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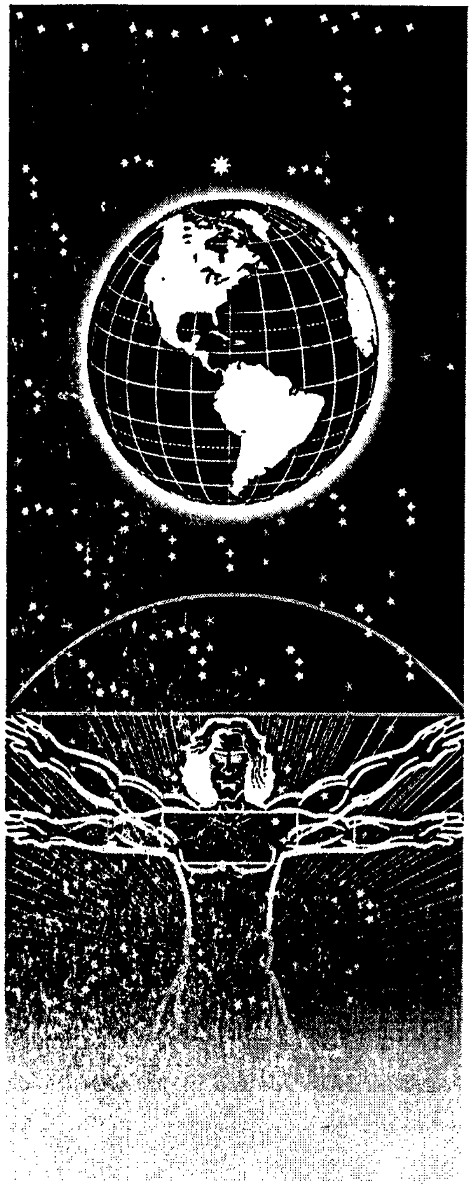

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Report on Alpha and End-User Testing of the Level I Ergonomics Methodology Guide Supplement for Warehouse and Service Areas

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13. ABSTRACT *(Maximum 200 words)*
This report describes the results of usability, reliability and validity tests applied to the Level I Ergonomics Methodology Guide Supplement for Warehouse and Service Areas. Testing was performed in two phases. In phase one (Alpha test), five experiences ergonomists used the methodology to evaluate ten representative United States Air Force (USAF) warehouse and service jobs and develop recommendations to eliminate identified ergonomics hazards. The ergonomists also participated in a focus session to recommend enhancements to the guide. In phase two (end-user test), the exercise was repeated by eight USAF bioenvironmental engineering technicians. Inter-rater agreement on the presence/absence of specific ergonomic hazards ranged from slight to fair. Agreement was higher among experienced ergonomists than among USAF technicians. Technicians found the methodology highly usable. The average time to complete and score the hazard identification checklist was 23.0 minutes, and the average time to select corrective actions for identified hazards was 13.6 minutes. The results suggest the methodology can enable relatively inexperienced USAF technicians to develop the same types of solutions for ergonomic hazards that an experienced ergonomist would recommend.

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

TABLE PAGE

Acronyms and Abbreviations

AFB	Air Force Base
AFI	Air Force Instruction
AFMC	Air Force Materiel Command
AFOSH	Air Force Occupational Safety and Health
BE	Bioenvironmental Engineering
BEF	Bioenvironmental Engineering Flight
BT	Back/Torso
CPE	Certified Professional Ergonomist
EPRA	Ergonomics Problem Area
HE	Head/Eyes
HWA	Hand/Wrist/Arm
IERA	Institute for Environment, Safety and Occupational Health (ESOH) Risk Analysis
LF	Legs/Feet
M/I	Maintenance and Inspection
MSM	MAJCOM Surveillance Manager
PES	Pacific Environmental Services, Inc.
SN	Shoulder/Neck
TJI/ADL	The Joyce Institute, a unit of Arthur D. Little, Inc.
TPM	Technical Program Manager
USAF	United States Air Force
WMSD	Work-Related Musculoskeletal Disorders
W/S	Warehouse and Service Areas

1.0 EXECUTIVE SUMMARY

1.1 INTRODUCTION

The U.S. Air Force has sponsored the development of standard ergonomics assessment methodology guides and management tools that will be integrated into the AFOSH Program. These methodologies and tools will be used as a means to minimize or eliminate work-related musculoskeletal disorders (WMSDs) associated with routine exposure to ergonomics risk factors at Air Force installations.

This Report on Alpha and End-user testing describes the test results for the Level I Ergonomics Methodology Guide Supplement for Warehouse and Service Areas (W/S Guide Supplement). The Guide Supplement is an addition to the Maintenance and Inspection Guide. The results from testing are an indication of the effectiveness with which base Bioenvironmental Engineering Flights (BEF) can use the methodology to conduct aggressive task-based problem solving in an Ergonomics Problem Area (EPRA).

1.2 TESTING PROCESS

The testing process was conducted in two primary phases: Alpha testing and End-user testing. During Alpha testing, ergonomists tested the Methodology. During the End-user testing, Air Force personnel tested the Methodology. The Methodology was tested for usability, reliability, and validity. End-user testing was performed to ensure that users would be able to apply the Methodology as intended. Reliability testing was performed to determine how consistently that application of the Methodology yielded the same results. Finally, validity testing was conducted to measure how closely the results from experienced ergonomists matched the results obtained by Air Force personnel. The methods, rationale, and results of the testing are detailed in this report.

The testing and data analysis applied to the W/S Guide Supplement was less detailed than that which was performed for the previous Administrative Guide and Maintenance and Inspection (M/I) Guide. Specifically, the following items were either not conducted, or conducted in a substantially different fashion, for the W/S Guide Supplement:

- A comparison to a "gold standard" ergonomist evaluation using independent assessment methodologies was not included in Alpha or End-user testing.

- The W/S Guide Supplement End-user testing included training on using the Guide, but did not on the two-hour briefing on ergonomics principles that was provided with previous beta

testing.

- Only eight Air Force personnel participated in End-user testing, instead of ten personnel proposed in the Test Plan.

- Only five VCR's with monitors were available for use by the eight participants, so some test subjects chose to complete the process after watching the videos rather than concurrently with the video.

Pacific Environmental Services, Inc. (PES), its critical subcontractor, The Joyce Institute/a unit of Arthur D. Little, Inc. (TJI/ADL), the IERA/RSHE Technical Program Manager (TPM), the IERA/RSHE Technical Consultant, and the MAJCOM Surveillance Manager (MSM), all agreed that the test results from the previous guides established the validity of the checklist and pattern matching methodology. The previous testing and data analysis for the Administrative and M/I Guides was extensive. It was agreed that repeating this level of detail would not likely result in additional information, or changes, to the format and content of this Guide Supplement, since the methodology used in the W/S Guide Supplement is very nearly identical to the previous Guides. The TPM, IERA/RSHE Technical Consultant, and MSM wanted to effectively manage costs on this Guide Supplement development. To this end, testing for this Guide Supplement was limited in scope.

There is an essential difference between the End-user test and previous beta tests. The purpose of the beta test was to verify the accuracy of the methodology when used by the target user population. The purpose of the End-user test was to verify the ability of the target population to use the methodology. Table 1.1 summarizes the differences between the two types of tests.

1.3 PROJECT RESULTS

The results of the testing process provide evidence of the validity, reliability, and practicality of the Methodology. The results are summarized below.

1.3.1 Reliability

The agreement between ergonomists during Alpha testing of the W/S Guide Supplement (59%, Kappa = 0.24) was nearly identical to the Alpha test agreement from the M/I Guide (64%, Kappa = 0.29). This is consistent with expectations since the checklist tools are highly similar.

The reliability results from the End-user testing did not meet expectations. The agreement results were considerably lower than those obtained during W/S Guide Supplement Alpha testing and the M/I Guide beta testing. Post hoc investigation of these results suggests that a combination of factors contributed to the decreased agreement among end-users in the testing of the W/S Guide Supplement, including:

- The amount of training provided for the W/S Guide Supplement user test subjects was less than that provided for the M/I beta test subjects. During the M/I Guide beta test, the ergonomist provided two types of training: instruction on the *process* required to participate in the testing; and, instruction in *ergonomics principles* so that the subjects would have a more comprehensive understanding of the significance of job factors and corrective actions. In the W/S Guide Supplement User test, the ergonomist provided the type of training specified in the protocol for the End-user test; namely, instruction in the *process*. Training in ergonomics principles was not provided since this was an End-user test, with different objectives from the beta test. The TJI/ADL test administrator, who has conducted various types of user tests, was concerned about introducing bias into the process and therefore hesitated to provide too much additional information during the test. He provided neutral instructions.

- Although there were five VCR monitors available for the eight test subjects, many times the subjects chose not to view the videotape while completing the checklist. The test administrator was hesitant to insist because he did not want to introduce bias. In previous beta tests, all of the subjects watched the videotapes while completing checklists. This may have been the result of a combination of differences in the administrators' specific verbal instructions and the fact that there were fewer VCR monitors than test subjects. However, given the room layout, all of the participants did have access to monitors and could have used them as they completed checklists. Completing checklists from memory, rather than from direct observation, could have a considerable negative impact on the consistency of the results.

- The types of jobs performed in the scenarios used for testing the W/S Guide Supplement often consisted of fewer tasks than the M/I Guide scenarios. This is due to the nature of many service jobs, such as a Dishwasher, which consist of a singular task (dishwashing) performed repetitively. In comparison, many maintenance jobs (such as jet engine repair) often include a greater variety of tasks (wrenching/ratcheting, prying, inspecting, and twisting/tying). Some of the case studies in previous guides have also addressed broad, singular task jobs, such as Wiring, Assembly/Repair – Benchwork, and Assembly/ Disassembly-Internal Components. The nature of the jobs in warehouse and services areas resulted in a greater number of one and two task jobs. This supplement continues to allow technicians to break a job down into one task or multiple tasks, depending upon which is most appropriate for the situation. An examination of the users' job evaluations indicates that many of the users broke jobs into more tasks than was necessary, based on the scenario instructions. Since agreement on job factor identification is based on the job factor being identified within the same task, these variations in task selection resulted in decreased agreement on job factor items.

- There were fewer End-user test subjects participating in the test than planned. This reduced the power of the subsequent analyses and made definitive conclusions about the meaning of the results more difficult.

Table 1.1
Comparison between Beta Testing and End-user Testing

	Beta Test	End-user Test
Emphasis	Verify the accuracy of methodology when used by target user population.	Verify usability of the methodology when used by target user population. The intention was a quick verification rather than the previous detailed studies.
Case Studies Evaluated	Thirty scenarios were evaluated by ten subjects covering approximately 35 of 50 case studies.	Ten scenarios were evaluated by eight subjects covering 10 of the 20 case studies.
Validity Testing	Results obtained during Alpha and beta testing were compared against an independent "gold standard" evaluation.	Gold standard evaluation not performed.
Inter-rater Reliability	Kappa valued for agreement on each job factor response.	Same.
Sensitivity Testing	The scenarios were classified as low, medium, and high based on the gold standard evaluation. Discriminant analysis was applied to beta test checklist results, Alpha test consensus results and gold standard results.	Gold standard evaluation not performed.
Solution Agreement	The ergonomists selection of corrective actions was compared to the beta test subjects to determine agreement.	Same.
End-user testing	Measurements of time and subjective responses.	The number of subjective responses was expanded and comment questions were added to increase the amount of usability information obtained. Field trials were called for in the Test Plan, but not completed due to time constraints at the base during the testing.

As a result of these factors, PES and TJI/ADL believe that the results of the End-user test do not accurately reflect the reliability of the W/S Guide Supplement. The fact that the results of the Alpha test are nearly identical to the Alpha test results from the M/I Guide, combined with the similarities in the Level I Checklists for these two tools, suggests that the performance of this Guide Supplement is similar to previous guides.

1.3.2 Validity

All of the job factor questions were supported by scientific research. The list of job factor questions was inclusive of the Job Factors common to warehouse and service tasks.

- The overall theoretical framework of the checklist was designed using all of the elements of the assessment tools that were previously validated. The checklist framework is consistent with the methodologies presented in the Level I Methodology Guides for Administrative Work Areas and for Maintenance and Inspection Work Areas.

- The corrective actions selected by the end-user agreed with the solutions selected by a consensus of ergonomists between 45% and 47% of the time. This was lower than the agreement rates obtained in testing previous guides. This reduced solution agreement is likely the result of decreased inter-rater agreement on the Job Factor questions, discussed in Reliability above. The selection of corrective actions in the case studies is organized by Job Factors. After identifying the presence of a Job Factor, the user references this Job Factor within the Case Study to identify an appropriate corrective action. If user agreement on Job Factor identification was reduced because of changes in the testing procedures, it would be anticipated that user agreement on corrective actions would also be reduced. Since the corrective actions are organized by Job Factors, users must first agree on the identification of job factors before corrective action agreement can occur. In spite of the reduced agreement on corrective action selection from previous testing, the current results suggest that the W/S Guide Supplement assists end-users in generating solutions that experts would recommend.

1.3.3 Practicality and Usability

The Methodology Guide Supplement received favorable usability comments and was well accepted by BEF technicians.

- The usability ratings for the W/S Guide Supplement are consistent with previous results. Each question rating had an average between 1.5 and 2.4 on a scale from 1 to 5, with scores of 1 indicating the most positive response. These scores indicate that participants had a generally favorable opinion towards the Methodology Guide Supplement. While the W/S Guide Supplement End-user testing had an expanded usability evaluation component from the M/I beta testing, the results are similar. The ratings for the M/I beta test ranged from 1.8 to 2.3.

- The W/S Guide Supplement met and improved on the "time for completion" requirements established by the Air Force. The mean time for completing the Level I Checklist and scoring process was 23.0 minutes with a standard deviation of 13.4 minutes. The mean time for identifying and selecting control measures was 13.6 minutes with a standard deviation of 9.1 minutes. The original criteria provided by the Air Force was one to two hours for data collection and analysis with an additional one to two hours for control identification.

1.4 CONCLUSIONS

PES and TJI/ADL do not consider results of the End-user test to accurately reflect on the reliability of the W/S Guide Supplement. The fact that the results of the Alpha test are nearly identical to the Alpha test results from the M/I Guide, combined with the similarities in the Level I Checklists for these two tools, suggests that the performance of this Guide Supplement is similar to previous guides. PES and TJI/ADL believe that additional End-user testing of the W/S Guide Supplement would not likely add appreciable value to the reliability or validity of the W/S Guide Supplement. Beta testing of previous Guides validates both the checklist design and the pattern matching process that are used in the W/S Guide Supplement.

2.0 DEVELOPMENT PROCESS SUMMARY

The U.S. Air Force has sponsored the development of standard ergonomics assessment methodology guides and management tools that will be integrated into the AFOSH Program. These methodologies and tools will be used as a means to minimize or eliminate work-related musculoskeletal disorders (WMSDs) associated with routine exposure to ergonomics risk factors at Air Force installations.

2.1 USE OF THE METHODOLOGY IN THE TIERED APPROACH TO PROBLEM-SOLVING

The W/S Guide Supplement Guide Supplement to the M/I Methodology Guide was developed to provide BEF with a process for conducting a basic ergonomics assessment. Through use of a simple pattern-matching process, the supplement identifies realistic controls that will effectively minimize or eliminate employee exposure to ergonomics hazards in jobs in warehousing and service areas, including such areas as food service, commissary tasks and patient care.

The requirements for the Methodology design were specified by Headquarters Air Force Materiel Command, Office of the Command Surgeon (HQ AFMC/SGC) and IERA/RSHE (formerly DET 1, HSC/OEMO). Both organizations desired an effective and efficient analysis and problem-solving process that could be applied to the full variety of Air Force warehousing and service work areas. The Methodology was to be designed to reflect the technical capabilities of a BEF technician with only two to three years of experience. In addition, the process was to place primary focus on identifying appropriate controls. Due to the high demands already placed on BEF personnel and the potential lack of ergonomics expertise, the Air Force requested that a "pattern-matching" process be created that would:

- minimize the time requirements for assessment and control identification; and
- enable the Air Force to benefit from the expertise of ergonomists who have had years of experience in addressing ergonomic hazards.

The Methodology is designed to enable the user, primarily through visual observations and employee/supervisor interviews, to:

- identify potentially hazardous tasks within a shop and job;
- determine if the content of the job and task(s) meet established ergonomics (risk factor exposure) criteria;

- determine which type(s) of additional (Level II) analyses may be used if further quantification of ergonomics hazards is required; and
- choose from a menu of control options (both short- and long-term) which when implemented, minimize the risk of musculoskeletal disorders and the hazards identified within the job and tasks.

The Methodology was designed to enable the user to complete data collection and analysis on a typical job in one to two hours, and complete the control identification and summary report in an additional one to two hours. The Methodology includes case studies for typical warehousing and service area tasks. The case studies serve as the basis for the pattern-matching process that is used to "match" the hazards identified in the tasks with controls that will reduce employee exposure to those hazards. The Methodology identifies metrics that can be used to evaluate the impact of ergonomics improvements on employee health, safety, and performance (e.g., quality, and productivity). A detailed description of the pattern-matching process is provided in the W/S Guide Supplement.

2.2 SCIENTIFIC BASIS FOR THE METHODOLOGY DESIGN

A literature review was conducted prior to the development of the Level I Methodology Guides for Administrative and M/I work areas. This literature review was completed to identify existing methodologies that could be used as the basis for the Level I Methodology. Initial results of the review indicated that comprehensive ergonomics analysis/problem-solving methodologies, using pattern-matching as the basis for control identification, did not previously exist.

As a result, the literature review was targeted to identify *analysis methods* upon which the Level I Ergonomics Assessment Checklist could be based. A detailed description of the literature review process was provided in the research report [1] from the initial Methodology development.

Prior to commencing development of the W/S Guide Supplement, TJI/ADL ergonomists conducted an additional literature review. The purpose of this literature review was to:

- Identify new methodologies for checklist assessment and determine the impact on the Level I Checklist design;
- Examine emerging research on risk factor exposure and WMSD exposure; and
- Identify analysis methods and proposed solutions which may be unique to warehouse and service tasks.

The additional literature review provided TJI/ADL with the most current research, particularly on materials handling issues. As a result of the search, TJI/ADL was able to provide additional

justification for the Risk Factor decisions and additional references for the Glossary. The Bibliography was expanded with the new references to enable the users to review the most current research on the topic.

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3.0 BASIS FOR VALIDATING THE METHODOLOGY

3.1 APPROACH

Testing of the Methodology was completed in two major steps: Alpha testing and End-user testing.

The purpose of Alpha testing was to provide an iterative basis for Methodology development. Experienced ergonomists served as test subjects to enhance the usability and reliability of the Methodology prior to subsequent testing. End-user testing examined the performance of the Methodology in a controlled environment designed to be as similar as possible to actual use. End-user testing used inexperienced BEF technicians to complete the testing.

A total of ten test job scenarios were developed containing video and text information for typical warehousing and service tasks (see Appendix E). The tasks for the Job Scenarios were selected to represent a variety of USAF warehousing and service tasks and a variety of risk factor exposures. The job scenarios are representative of tasks that would typically be considered for ergonomics intervention, rather than all warehouse and service tasks. As a result, each task had some exposure to most ergonomics hazards. The Job Scenarios presented a "standardized" result of the data collection process to ensure that each person using the Methodology based their answers on the same information. In actual use, the data collection process is a critical component for obtaining results with the Methodology. The potential for variations within the data collection for each Level I assessment were not evaluated. It is expected that training and experience will result in consistently accurate data collection. These same test job scenarios were used for both Alpha and End-user testing.

3.2 METHOD

3.2.1 Research Design

It was estimated the five subjects would be sufficient for the Alpha test to provide a preliminary evaluation of the guide and to provide guidance for required changes. It was also estimated that ten subjects would be sufficient to demonstrate the utility of the Methodology. The End-user testing was designed to use ten BEF technicians as subjects. Only eight technicians were available for testing. Each subject (five in Alpha test, eight in End-user test) evaluated each of the ten Job Scenarios. The scenarios were administered in random order to control order effects. This was, therefore, a repeated measures design, with multiple dependent measures. The dependent measures collected for each scenario were: the responses to each of 24 Job Factor questions; the priority scores and ratings for each of the five body regions (shoulder/neck, hand/wrist/arm, back/torso, legs/feet and head/eyes); the overall priority rating for the job; the

corrective action selections; and, the time required to complete the evaluation.

3.2.2 Alpha Testing

Alpha testing refers to testing performed by the ergonomists during the Guide Supplement development process.

3.2.2.1 Subjects. Five ADL/TJI ergonomists participated in Alpha testing. These ergonomists were experienced in the use of assessment tools and ergonomics checklists. Each ergonomist participating in the Alpha test had an advanced degree in the field and at least five years of full-time ergonomics experience. Four of the ergonomists were Certified Professional Ergonomists (CPE).

3.2.2.2 Procedure and Apparatus. Each of the ergonomists was provided with the following materials:

- Ten Written Job Scenarios and the corresponding video tape;
- Level I Ergonomics Assessment Checklist (draft 1) and Scoring Summary;
- Corrective Action List (part of Checklist Scoring Summary);
- Case Study Manual (draft 1); and,
- User's Instructions.

The ergonomists reviewed the videotapes and their responses to the Ergonomics Assessment Checklists. Based on this information, the ergonomists selected solutions from the case study manual. Each ergonomist selected solutions from the case study manual for all ten jobs. After this was completed, one ergonomist led a focus group session to determine enhancements to the case study manual.

The Level I Ergonomics Assessment Checklist was used to analyze the job. The Checklist Scoring Summary was used to score the checklist and record results of the pattern-matching process using the Case Study Problem-Solving Matrices. User's instructions were provided to ensure that each ergonomist followed the same procedure for applying the Methodology. During a group meeting, the ergonomists commented on the usability of the Methodology components and user's instructions. A second draft of the checklists and scenarios was developed to reflect these comments. Section 4.1.2 of this report discusses changes to the checklists. The scenarios were modified to reflect the tasks shown in the videotape, rather than all potential tasks that someone doing that job *might* perform. It was determined, as in previous Guide testing, that there was insufficient information to accurately answer or evaluate the environmental questions. Since these questions do not figure in the scoring and are not reflected in the Case Studies, no analysis was conducted on these questions.

3.2.3 End-user Testing

3.2.3.1 Subjects. Eight Air Force personnel were selected to participate in a single-step

End-user test. These personnel were selected by AFMC to "match" the targeted end-user population: BEF technicians with two to three years of experience. Eight personnel were provided and the test was conducted at Hill AFB.

Ten subjects were originally requested for the End-user testing. The rationale for selecting ten as the appropriate number of subjects was based on the practicalities of conducting the research. The time frame and the budget for this project permitted only ten subjects' data to be collected and analyzed. Ten subjects have been sufficient to demonstrate reliability in previous guide testing. While the impact of reducing the number of subjects from ten to eight is not clear, it is unlikely that the reduction in subjects improved the inter-rater agreement.

3.2.3.2 Procedure and Apparatus. Each of the End-user testers was provided with the following materials:

- Ten Written Job Scenarios and corresponding video tape;
- Level I Ergonomics Assessment Checklist (draft 2) and Scoring Summary;
- Corrective Action List (part of Checklist Scoring Summary);
- Case Study Manual (draft 2), and;
- User's Instructions.

The testing process and materials provided were the same as for the Alpha test with the appropriate revisions to the methodology from the Alpha test focus group. Each End-user test subject followed the User's Instructions to apply the Methodology to each of the Job Scenarios. The testing process was completed in two days. Each End-user test subject was also asked to record the amount of time required to complete both the Level I Ergonomics Assessment Checklist/Checklist Scoring Summary and the pattern-matching/control-identification process for each Job Scenario. Each participant completed a survey regarding the usability of the Guide Supplement at the end of the End-user test.

3.3 DATA ANALYSIS AND SCIENTIFIC BASIS

The purpose of the data analysis was to show that the design of the Level I Methodology meets the project goals. To do this, it was necessary to demonstrate that the Methodology is reliable, valid and practical. These concepts are easily defined.

A scale is said to be valid if it measures what it is intended to measure. An ergonomics assessment tool, such as the Level I Checklist, should measure some aspect of human health, comfort or performance in order to be a valid measure. Reliability, on the other hand, refers to the accuracy and the repeatability of the measurement of a variable. The reliability of an instrument is the foundation for the other concepts. An instrument must be reliable in order to be valid, since one can not be sure that the "valid results" obtained one time will be repeated. Practicality identifies the usefulness and usability of an instrument.

Reliability testing of assessment tools generally takes one of two forms: test/re-test reliability and inter-rater reliability. Test/re-test reliability defines how well the same person will achieve the same results using a tool at different times. Inter-rater reliability defines how well different people will agree on the results.

Several techniques have been used and reported for inter-rater reliability testing with ergonomic assessment tools. The coefficient of variation was used in one study (Stetson et al, 1991 [2]) with scores of less than 20 percent for most measures. Multiple regression has also been used [2] with a finding of no statistically significant differences between raters supporting reliability. Kemmlert (1994) [3] found weighted averages of Kappa ranging from 0.24 to 0.44 and a percent agreement often above 70 percent. Keyserling, Stetson, Silverstein and Brouwer (1993) [4] used inter-rater agreement percentages as a part of their validation. There is little consensus on the best methods for demonstrating inter-observer agreement (Meister, 1985 [5]).

Individual questions were evaluated for reliability by calculating Kappa statistics for the Alpha and End-user tests. The Kappa statistic was chosen because it represents an accurate method for testing reliability while controlling for the effects of chance. The data meet all of the assumptions for Kappa (Cohen, 1960 [6]; Brennan & Prediger, 1981[7]) which are:

- the objects are categorized and independent;
- the raters operate independently; and
- the categories are independent, mutually exclusive, and exhaustive.

Since it was expected that a certain amount of agreement would occur by chance, like having 50% correct on a true/false test, the Kappa statistic reports agreement after chance has been removed. A Kappa value can be interpreted as a percent of agreement, for instance a Kappa of 0.75 indicates an agreement rate of 75% after chance has been removed.

For interpreting the Kappa values the interpretations shown in Table 3.1 were used, consistent with those suggested by Landis and Koch (1977) [8]. Kappa values were considered to be statistically significant if the 95% Lower Confidence Interval (LCI) exceeded 0.0.

The scores (item level, body region level, and risk rating) from both the Alpha and End-user test sessions were analyzed independently using the Kappa statistic.

Table 3.1
Kappa Value Interpretation

Kappa Values	Interpretation
0.81 to 1.0	Almost Perfect
0.61 to 0.80	Substantial
0.41 to 0.60	Moderate
0.21 to 0.40	Fair
0.0 to 0.20	Slight
< 0.0	Poor

The validity of an instrument refers to the property of measuring what is intended. A variety of methods have been used to establish the validity of ergonomic assessment procedures. The most common types of instrument validity are:

- ***Predictive validity***: Predictive validity answers the question, "Do the results of the instrument accurately predict outcome measures?" Predictive validity is also referred to as criterion-related validity. In the evaluation of ergonomics assessment instruments, predictive validity has been suggested through comparisons with incidence rate [9] and with discomfort ratings [10]. For instance, an assessment instrument that predicts incidence or discomfort rates would have predictive validity. Any predictive validity measures for simple ergonomics assessment techniques are subject to confounding variables that could greatly reduce the statistical power. Predictive validity was not assessed for any of the three Guides.

- ***Concurrent validity***: Concurrent validity addresses whether two independent assessment methods produce similar results. The rationale underlying concurrent validity is that if two independent techniques produce the same results, the likelihood that the instrument is measuring the intended characteristic is increased. In the evaluation of ergonomics assessment instruments, concurrent validity has been supported through comparing expert ratings on two different techniques [3] and by comparing novice users of a simple technique with expert users of a more detailed methodology [4].

  The primary method for assessing the concurrent validity of the previous guides was to compare the test evaluations (simple technique) with the Gold Standard. The Gold Standard refers to the ergonomists who completed an independent assessment, using alternate assessment methods, of the jobs in the Administrative and M/I Guide development process. The purpose of the Gold Standard was to provide an indicator of concurrent validity and to suggest content changes to the methodology during Alpha testing. The factors which were considered when selecting the Gold Standard ergonomists were: experience in industrial ergonomics training, workstation adjustments and modifications, and equipment design; first-hand knowledge of Air Force jobs; and limited involvement in the Level I Guide development. The Gold Standard results were compared to the Alpha and beta results as part

of the testing for the Administrative and M/I Guides. Due to the similarities between the W/S Guide Supplement and M/I Guides, the Gold Standard comparison was not incorporated into the testing design for the W/S Guide Supplement.

- *Content validity*: Content validity refers to the degree to which the items used in an instrument are factors that are considered important in the intended characteristic. Content validity has been reported as an item match with scientific literature [3]. The content validity was based on using referenced criteria to select questions during tool development. Kemmlert [3] reports content validity for the PLIBEL method. Scientific literature was reviewed to provide references for each item in PLIBEL. The primary approach for assessing content validity for the Level I Checklist was to provide support in the literature (particularly validated assessment tools) for all Job Factor questions and scaling approaches.

While the practicality of the Methodology is perhaps the most important consideration, it is also the most difficult to quantify in a short-term test. The solid test of practicality is how frequently the tool is applied in examining workstations and the results obtained through the changes. In the shorter-term, several measures were used to examine the practicality of the tool. The usability comments were tabulated, with the assumption that a highly useable tool is more practical than other tools. The descriptive statistics of time requirements were compared to the criteria established, with the assumption that an effective tool that can be completed within the time suggestions has some practicality. The overall agreement regarding solution options was calculated and reported, based on the assumption that a method which leads to consistent solution recommendations is practical. While none of these measures proves practicality, positive results in all these areas would suggest that technicians would find that the tool is a practical one to use.

4.0 RESULTS

4.1 RELIABILITY

4.1.1 Summary

The reliability results from the Alpha test of the W/S Guide Supplement are similar to the results obtained during the Alpha testing of the M/I Guide. The average agreements were both near 60% (W/S Guide Supplement=59%, M/I=64%). The mean value of Kappa for individual questions is also similar between the test groups (W/S Guide Supplement = 0.24, M/I = 0.29). These rates are within the range of weighted averages of Kappa (0.24 to 0.44) found by Kemmlert [3]. These results indicate a consistent agreement on individual question, and this agreement is classified in the slight to fair range. The similarity in results between the two guides is consistent with TJI/ADL's expectations, since the checklist part of the W/S Guide Supplement is nearly identical to the M/I Guide.

Although some individual questions had lower agreement during the Alpha test of the W/S Guide Supplement than they had on the Alpha test of the M/I Guide, the confidence intervals displayed considerable overlap in most cases. It was also the case that many questions had better agreement during the W/S Guide Supplement Guide Supplement Alpha test than they had on the M/I Guide Alpha test, still with overlapping confidence intervals. The most plausible explanation is that the checklist tool (which is essentially identical) is equally effective for the scenarios used in the W/S Guide Supplement and the M/I Guide Alpha tests. The lower number of task scenarios in the W/S Guide Supplement testing (10 scenarios, 11 tasks) than in the M/I Guide testing (30 scenarios, 70 tasks) reduced the power of the test and resulted in larger confidence intervals in the W/S Guide Supplement test results. As a result it would be risky to conclude that those few questions that had lower scores in the W/S Guide Supplement test than the M/I Guide test were the result of small changes in the checklist tool or substantive differences between W/S Guide Supplement and M/I Guide task characteristics. It would be equally irresponsible to conclude that those questions that had higher scores on the W/S Guide Supplement test than the M/I Guide test indicated improvement in the checklist tool.

Those questions that had a Kappa < 0.20 are discussed in greater detail in Table 4.2 in order to examine the potential for improvements to the checklist tool.

The reliability results from the End-user testing, however, did not meet TJI/ADL's expectations. The agreement results were considerably lower than those obtained during W/S Guide Supplement Alpha testing and the M/I Guide beta testing. Post hoc investigation of these results suggests that a combination of factors contributed to the decreased agreement among end-users in the testing of the W/S Guide Supplement, including:

- The amount of training provided for the W/S Guide Supplement user test subjects was less than that provided for the M/I beta tester subjects. During the M/I Guide beta test, the ergonomist provided two types of training: instruction on the *process* required to participate in the testing; and, instruction in *ergonomics principles* so that the subjects would have a more comprehensive understanding of the significance of job factors and corrective actions. In the W/S Guide Supplement End-user test, the ergonomist provided the type of training specified in the protocol for the End-user test; namely, instruction in the *process.* Training in ergonomics principles was not provided since this was an End-user test, with different objectives from the beta test. The TJI/ADL test administrator, who has conducted various types of user tests, was concerned about introducing bias into the process and therefore hesitated to provide too much additional information during the test.

- Although there were five VCR monitors available for the eight test subjects, many times the subjects chose not to view the videotape while completing the checklist. The test administrator was hesitant to insist because he did not want to introduce bias. In previous beta tests, all of the subjects watched the videotapes while completing checklists. This may have been the result of a combination of differences in the administrators' specific verbal instructions and the fact that there were fewer VCR monitors than test subjects. However, given the room layout, all of the participants did have access to monitors and could have used them as they completed checklists. Completing checklists from memory, rather than from direct observation, could have a considerable negative impact on the consistency of the results.

- The types of jobs performed in the scenarios used for testing the W/S Guide Supplement often consisted of fewer tasks than the M/I Guide scenarios. This is due to the nature of many service jobs, such as a Dishwasher, which consist of a singular task (dishwashing) performed repetitively. In comparison, many maintenance jobs (such as jet engine repair) often include a greater variety of tasks (wrenching/ratcheting, prying, inspecting, and twisting/tying). Some of the case studies in previous guides have also addressed broad, singular task jobs, such as Wiring, Assembly/Repair – Benchwork, and Assembly/ Disassembly-Internal Components. The nature of the jobs in warehouse and services areas resulted in a greater number of one and two task jobs. This supplement continues to allow technicians to break a job down into one task or multiple tasks, depending upon which is most appropriate for the situation. An examination of the users' job evaluations indicates that many of the users broke jobs into more tasks than was necessary, based on the scenario instructions. Since agreement on job factor identification is based on the job factor being identified within the same task, these variations in task selection resulted in decreased agreement on job factor items.

- There were fewer End-user test subjects participating in the test than planned. This reduced the power of the subsequent analyses and made definitive conclusions about the meaning of the results more difficult.

As a result of these factors, PES and TJI/ADL believe that the results of the End-user test do not accurately reflect the reliability of the W/S Guide Supplement. The fact that the results of the

Alpha test are nearly identical to the Alpha test results from the M/I Guide, combined with the similarities in the Level I Checklists for these two tools, suggests that the performance of this Guide Supplement is similar to previous guides.

4.1.2 Task Selection Strategies

End-users selected a wide range of tasks to include in the analysis. One purpose of the highly structured scenarios was to minimize variation at the task selection level. This was not the result in the End-user testing. In addition to including tasks that were not listed in the scenario instructions, many users included tasks that are not on the task list. For instance, in this testing protocol some of the variations observed on the meatpacking scenario were:

- Using one task: meat cutting (which directly corresponds to the scenario instructions).
- Using three tasks: cutting meat, wrapping meat, placing meat on trays (two of which are not on the task list).
- Using three tasks: knife, band saw and unpacking (none of which are on the task list).
- Using three tasks: lifting, cutting and packaging.

These changes in task selection alter the task duration and thus the score assigned to a Job Factor Frequency Rating. Furthermore, breaking the job into different tasks will result in different Job Factor Frequency Ratings. For instance, assume the two types of cutting (knife and band saw) account for 40% each of the total job time. Also assume that the job factor "bent wrist" occurs repeatedly with the knife but not with the band saw. If these are combined as a single meat-cutting task, consistent with the task description in the case studies, a Job Factor occurs "Sometimes" in a task with "High" Task Frequency. In the two types of cutting, however, a Job Factor occurred "Frequently" in a task with "Moderate" Task Frequency. The greater the variation in task selection, the greater the variation in responses and scoring. The purpose of highly structured scenarios was to eliminate this potential variation from the test scenario structures were very effective in this regard in previous testing. Training and experience should reduce variation in actual use.

The structure of the case studies and task list may have contributed to this increased variation in task selection. While the W/S Guide Supplement does not abandon the concept of breaking jobs into component tasks, the types of jobs performed in W/S Guide Supplement scenarios often consisted of fewer tasks than the M/I Guide scenarios. This is the result of the nature of many service jobs (such as a dishwasher) which consist of a singular task (dishwashing) performed repetitively. In comparison, many maintenance jobs (such as jet engine repair) often include a greater variety of tasks (wrenching/ratcheting, prying, inspecting, and twisting/tying).

The discussion regarding the distinction between task and job has been an on-going one during this development process. Some of the case studies in previous guides have also addressed broad, singular task jobs, for example, Wiring, Assembly/Repair – Benchwork, and Assembly/ Disassembly-Internal Components. The nature of the jobs in warehouse and services areas result in a greater number of broad, singular task jobs. This W/S Guide Supplement continues to allow technicians to break jobs down into one task or multiple tasks, depending upon which is most appropriate for the situation. During the testing of the W/S Guide Supplement, some participants created generic task types, in addition to the specific job function, to describe the jobs. As a result, participants analyzed very different sets of tasks.

The instructions appear straightforward and complete: "identify the tasks in the Specific Tasks and Times and write the task names in the Work Content Matrix." The written instructions were the same instructions provided for the testing of the M/I Guide. Post hoc investigation revealed that the TJI/ADL administrator of the M/I beta testing instructed participants to directly transfer the tasks listed in the Specific Task and Time table on the scenario into the Work Content Matrix. Similar verbal instructions were not provided during the W/S Guide Supplement End-user test. This subtle addition to the written instructions provided may have decreased the likelihood that participants would add tasks to the list provided in prior testing sessions.

4.1.3 Checklist Completion Methods

The lack of television monitors, discussed in Section 4.1.1, for End-user testing may have also contributed this style of checklist completion. Since eight test subjects shared five video monitors, some subjects watched the video and then completed the checklist from memory.

Completing a checklist from memory is likely to be less accurate than completing the checklist "live." In previous test sessions, the test subjects completed the checklist while watching the video. This explains the inclusion of tasks that were not contained on the video (such as bagging in the Scanning Groceries example), and resulted in reduced agreement among test subjects.

4.1.4 Job Factor Question Agreement

The percent agreement and Kappa value were calculated for each job factor question on the Alpha and End-user tests. The percent agreement is based on the formula for determining "percent observed" within the generalized Kappa model (Bartko & Carpenter [11]). A generalized, simple Kappa appropriate for multiple raters and response categories [11] is reported for item agreement for both the Alpha and End-user tests. The 95% Upper and Lower Confidence Intervals are reported for each question. The response rates for scored responses (scores greater than zero) are also reported.

The general level of agreement between ergonomists using the Level I Checklist is presented in Table 4.1. The agreement rates, not corrected for chance, for the Alpha test questions ranged between 29% and 71% for those questions with sufficient response rates of risk factor presence. A

minimum of ten non-zero responses was established to define sufficient response rates for both the Alpha and End-user test. In the Alpha test, five questions did not have sufficient response rates to meaningfully interpret (questions 7, 18, 22, 23 and 24). Previously, Kemmlert [3] found agreement Kappa values in the fair to moderate range for individual questions. Those questions which did not meet this level of agreement, but had a sufficient number of responses, are shaded in Table 4.1. These shaded questions indicate those items that are potentially problematic in the W/S Guide Supplement. A discussion of each of these questions is presented in Table 4.2.

The ergonomists determined that a compelling reason for changing a question would be needed before substantially altering the question. This was based on the desire to keep the instrument compatible with the M/I Guide. There were several changes made to this Guide Supplement to address the issues raised by the Alpha test. The ergonomists reviewed all elements of the Guide Supplement and made the following revisions after Alpha testing:

- Placed an <OR> in between the two parts of Job Factor questions 1 and 16.

- Made modifications to Job Factor pictures for checklist questions: 1, 2, 3, 9, 11, 14, 15, and 24.

- Made modifications to Job Factor examples for checklist questions: 5, 8, 9, 10, 18, 19, 20 22, 23, and 24.

- Provided numerous picture revisions to the glossary.

Table 4.1
Testing of the Item Agreement Among Ergonomists for Alpha Test

Question	Percent	Kappa	95%LCI	95%UCI	non-zero observations
1. Reaching	49%	0.28	0.13	0.42	49
2. Arm Forces	61%	0.43	0.29	0.57	37
3. High speed shoulder movement	62%	0.29	0.05	0.52	21
4. Neck bent	29%	0.08	-0.03	0.19	48
5. Wrist bent	55%	0.37	0.23	0.50	48
6. Finger repetitions	59%	0.26	0.02	0.49	21
7. Single finger	74%	-0.02	-0.59	0.55	7
8. Hand grip forces	39%	0.16	0.02	0.30	43
9. High speed HWA or HWA vibration	47%	0.11	-0.12	0.33	21
10. Hard edges	45%	0.09	-0.11	0.29	24
11. Cold temperatures	67%	0.37	0.09	0.65	18
12. Back bending	42%	0.18	0.04	0.32	42
13. Back twisting	41%	0.15	0.01	0.30	43
14. High speed back movements	54%	0.07	-0.21	0.34	18
15. Static back position	26%	-0.01	-0.14	0.12	33
16. Back forces	56%	0.40	0.28	0.53	37
17. Pushing/Pulling	71%	0.34	-0.01	0.69	14
18. Whole body vibration	91%	0.33	-0.57	1.23	3
19. Fixed position standing	56%	0.29	0.08	0.51	42
20. Exposure to hard edges	33%	-0.01	-0.18	0.16	27
21. Awkward leg postures	70%	0.24	-0.16	0.65	12
22. Awkward foot postures	98%	0.49	-1.44	2.41	0
23. Light levels	85%	0.37	-0.28	1.01	6
24. Intensive staring	85%	0.44	-0.15	1.02	7

Table 4.2
Discussion of Job Factor Questions with Kappa < 0.20
W/S Guide Supplement Alpha Test Results

Question	W/S Guide Supplement Kappa	95% UCI	MI Kappa	95% LCI	Comments
4. Neck bent	0.08	0.19	0.36	0.11	There was an 82% consensus rate when examining simply job factor presence. The low agreement on this question appear to be primarily related to rating the duration of this factor. No change was recommended.
7. Single finger	-0.02	0.55	0.29	0.19	Although the response rate on this question was too low to accurately interpret the results, it was included in the table to illustrate the number of hand/wrist/arm (HWA) questions with low agreement. In spite of having lower agreement on 4 of the 7 HWA questions, the W/S Guide Supplement test had higher agreement on the W/S Guide Supplement Priority Rating.
8. Hand grip forces	0.16	0.30	0.24	0.10	There was a 73% consensus rate when examining simply job factor presence. The low agreement on this question appeared to be primarily related to rating the duration of this factor. The degree of overlap in the confidence intervals between the W/S Guide Supplement and M/I tests suggests the lack of a real difference. The W/S Guide Supplement test also resulted in improved agreement on HWA ratings suggesting that additional changes may not be needed. No change was recommended.

Table 4.2 continued

Question	W/S Guide Supplement Kappa	95% UCI	MI Kappa	95% LCI	Comments
9. High speed HWA or HWA vibration	0.11	0.33	0.15	0.08	The degree of overlap in the confidence intervals between the W/S Guide Supplement and M/I tests suggests the lack of a real difference. Subjects may have had some difficulty interpreting "high speed" in this question and in question 14.
10. Hard edges	0.09	0.29	0.12	0.02	The degree of overlap in the confidence intervals between the W/S Guide Supplement and M/I tests suggests the lack of a real difference. The W/S Guide Supplement test also resulted in improved agreement on HWA ratings suggesting that additional changes may not be needed. No change was recommended.
12. Back bending	0.18	0.32	0.22	0.13	The degree of overlap in the confidence intervals between the W/S Guide Supplement and M/I tests suggests the lack of a real difference. Based on discussions between the ergonomists, it appeared that moderate amounts of sideways bending (#12) and twisting (#13) are often interchanged when scoring the checklist. This resulted in disagreement at the item level and agreement at the body region level. The W/S Guide Supplement test resulted in improved agreement on Back/Torso (BT) ratings suggesting that additional changes may not be needed. No change was recommended.

Table 4.2 continued

Question	W/S Guide Supplement Kappa	95% UCI	MI Kappa	95% LCI	Comments
13. Back twisting	0.15	0.30	0.45	0.32	Based on discussions between the ergonomists, it appeared that moderate amounts of sideways bending (#12) and twisting (#13) are often interchanged when scoring the checklist. This results in disagreement at the item level and agreement at the body region level. The W/S Guide Supplement test resulted in improved agreement on BT ratings suggesting additional changes may not be needed. No change was recommended for this question.
14. High speed back movements	0.07	0.34	0.36	0.13	The degree of overlap in the confidence intervals between the W/S Guide Supplement and M/I tests suggests the lack of a real difference. Subjects may have had some difficulty interpreting "high speed" in this question and in question 9. No change was recommended.

Table 4.2 continued

Question	W/S Guide Supplement Kappa	95% UCI	MI Kappa	95% LCI	Comments
15. Static back position	-0.01	0.12	0.21	0.17	One ergonomist scored all standing tasks as static back postures, inferring that all standing tasks are stressful on the back. This interpretation is beyond the wording of the question. This problem was not identified previously because this ergonomist did not participant in previous Alpha tests. This ergonomist was also the least experienced in the use of the Level I assessments. When this ergonomist's data was removed, the agreement was consistent with previous test results. This appears to be a case " knowing too much" and reading this knowledge into questions. This error is not likely to be repeated by end-users. No change was the question is recommended.
20. Exposure to hard edges	-0.01	0.16	0.35	0.12	At the conclusion of Alpha testing this question was modified to incorporate hard floor surfaces. This should lead to improved agreement.

The job factor questions were also evaluated by calculating the percentage of time the ergonomists reached a consensus level of 80% on responses. Three separate measures of consensus are included: consensus on duration (Never, Occasionally, Sometimes or Frequently); consensus on Job Factor occurrence; and consensus on Job Factor absence. The calculation of the consensus rate is an additional measure of agreement requested by the IERA/RSHE Technical Consultant. While there is no single agreed upon measure of agreement, as stated previously, both methods (Kappa and consensus rates) are accepted approaches to reporting agreement. The approximate consensus rate has been reported; however, since the request for certain types of analysis had not been

anticipated when the Work Plan for this effort was approved, the data input was not structured in such a way to allow this to be accomplished quickly. The data is input by job factor score (0, 1, 3, 4, ...), rather than by duration designator (N, O, S and F).

An analysis was performed to indicate the relative direction this data may take by treating all "O's" as "Never's". It should be noted that this is not exactly accurate, but should be indicative of the response trends. The results of this analysis for the Alpha test are presented in Table 4.3. The average overall consensus rate across all job factor questions for ergonomists was 53%. This consensus rate improved to 73% (34% for job factor present, and 39% for job factor absent) when considering only the presence or absence of job factors.

Table 4.4 shows Kappa results for the End-user tests. The overall agreement was slight, (raw agreement 47%, mean value of Kappa = 0.11). Only four questions fell in, or above, the range of Kappa values found in the checklist study by Kemmlert [3].

Table 4.5 presents the End-user test consensus rates for each job factor question. The same limitations noted in the Alpha test consensus rate calculations apply to the End-user test. Just as the Kappa results for the end-users was lower than the Alpha test, the consensus rate was also less. The average overall consensus rate across all job factor questions for end-users was 24%. This consensus rate improved to 53% when considering only the presence or absence of job factors.

4.1.5 Overall Score Agreement

The reliability of the Level I Checklist ratings for the body regions and overall job were measured using a generalized Kappa statistic [11], the coefficient of variance and the rate of consensus. The rate of consensus is reported for overall agreement, agreement for each job priority rating (High, Medium and Low), and agreement that job priority indicated intervention was warranted (either High or Medium). The Alpha test results of these evaluations are presented in Tables 4.6, 4.7, and 4.8. The End-user test results of these evaluation are presented in Tables 4.9, 4.10, and 4.11.

The Kappa results from the W/S Guide Supplement Alpha test are presented along with a summary of the M/I Guide Alpha test results. A comparison of the body region priority rating agreement obtained during W/S Guide Supplement Alpha testing with that obtained during M/I Guide Alpha testing indicates highly similar results. Although the Kappa values vary between the two testing sessions, there is considerable overlap in the confidence intervals suggesting that the most reasonable conclusion would be that the W/S Guide Supplement and M/I Guide Alpha test results were similar. One might cautiously conclude that the W/S Guide Supplement Alpha test results suggested an improvement over the M/I Guide results based on improvement in three of the five (hand/wrist, back/torso and head/eyes) body regions and the overall job rating, particularly since it appears intuitive that hand/wrist and back/torso job factors would be more clearly evident in a set of jobs that included warehousing, cashiers and meat cutting operations. Such a conclusion should be cautious and tentative, based on the degree of overlap in the confidence intervals.

Table 4.3
Level of Consensus (80% Agreement) on Job Factor Questions
W/S Guide Supplement Alpha Test Results

Question	Overall Consensus Rate	Job Factors Present Consensus Rate	Job Factors Absent Consensus Rate
1. Reaching	55%	91%	0%
2. Arm Forces	55%	64%	18%
3. High speed shoulder movement	64%	18%	45%
4. Neck bent	18%	82%	0%
5. Wrist bent	55%	82%	0%
6. Finger repetitions	64%	18%	45%
7. Single finger	91%	0%	91%
8. Hand grip forces	18%	73%	0%
9. High speed HWA or HWA vibration	36%	9%	27%
10. Hard edges	27%	27%	27%
11. Cold temperatures	73%	27%	64%
12. Back bending	27%	64%	9%
13. Back twisting	9%	55%	0%
14. High speed back movements	45%	9%	45%
15. Static back position	9%	18%	9%
16. Back forces	36%	64%	18%
17. Pushing/Pulling	73%	18%	73%
18. Whole body vibration	91%	0%	91%
19. Fixed position standing	55%	64%	0%
20. Exposure to hard edges	18%	18%	18%
21. Awkward leg postures	82%	9%	82%
22. Awkward foot postures	100%	0%	100%
23. Light levels	82%	9%	82%
24. Intensive staring	82%	9%	82%

Table 4.4
Testing of the Item Agreement Among End Users

Question	Raw Percent	Kappa	95% LCI	95% UCI	Non-zero Observations
1. Reaching	37%	0.09	-0.02	0.20	78
2. Arm Forces	36%	0.06	-0.04	0.16	50
3. High speed shoulder movement	42%	0.01	-0.15	0.17	37
4. Neck bent	31%	0.10	0.02	0.18	80
5. Wrist bent	37%	0.10	0.02	0.19	81
6. Finger repetitions	58%	0.11	-0.12	0.35	27
7. Single finger	61%	0.10	-0.15	0.35	25
8. Hand grip forces	33%	0.14	0.07	0.21	69
9. High speed HWA or HWA vibration	33%	0.00	-0.14	0.13	42
10. Hard edges	37%	0.06	-0.06	0.18	45
11. Cold temperatures	61%	0.35	0.18	0.51	37
12. Back bending	30%	0.04	-0.03	0.11	67
13. Back twisting	31%	0.11	0.05	0.18	65
14. High speed back movements	46%	0.17	0.06	0.29	47
15. Static back position	34%	0.07	-0.02	0.15	70
16. Back forces	43%	0.16	0.04	0.28	46
17. Pushing/Pulling	56%	0.13	-0.10	0.37	28
18. Whole body vibration	92%	0.04	-0.89	0.97	4
19. Fixed position standing	49%	0.28	0.20	0.37	66
20. Exposure to hard edges	34%	0.10	0.03	0.18	66
21. Awkward leg postures	56%	0.21	0.03	0.38	34
22. Awkward foot postures	78%	-0.07	-0.60	0.47	10
23. Light levels	63%	0.23	-0.01	0.48	27
24. Intensive staring	58%	0.13	-0.11	0.37	27

Table 4.5
Level of Consensus (80% Agreement) on Job Factor Questions
End-user Test Results

Question	Overall Consensus Rate	Job Factors Present Consensus Rate	Job Factors Absent Consensus Rate
1. Reaching	0%	82%	0%
2. Arm Forces	9%	36%	9%
3. High speed shoulder movement	18%	0%	18%
4. Neck bent	0%	91%	0%
5. Wrist bent	0%	91%	0%
6. Finger repetitions	27%	9%	27%
7. Single finger	45%	0%	45%
8. Hand grip forces	0%	45%	0%
9. High speed HWA or HWA vibration	0%	0%	0%
10. Hard edges	9%	0%	9%
11. Cold temperatures	45%	18%	45%
12. Back bending	0%	64%	0%
13. Back twisting	0%	45%	0%
14. High speed back movements	18%	27%	18%
15. Static back position	0%	55%	0%
16. Back forces	27%	27%	27%
17. Pushing/Pulling	45%	0%	45%
18. Whole body vibration	91%	0%	91%
19. Fixed position standing	27%	64%	18%
20. Exposure to hard edges	9%	45%	0%
21. Awkward leg postures	36%	9%	27%
22. Awkward foot postures	91%	0%	91%
23. Light levels	36%	9%	36%
24. Intensive staring	45%	9%	45%

Table 4.6
Agreement (Kappa) on Body Region and Overall Job Ratings
Alpha Test Results

	W/S Guide Supplement percent	W/S Guide Supplement Kappa	95% LCI	95% UCI	MI%	MI Kappa
Job SN	0.47	0.14	-0.04	0.32	0.59	0.30
Job HWA	0.62	0.40	0.23	0.57	0.57	0.27
Job BT	0.53	0.20	-0.01	0.42	0.45	0.14
Job LF	0.43	0.00	-0.19	0.19	0.55	0.20
Job HE	0.96	0.73	-0.15	1.61	0.74	0.22
Job Overall	0.75	0.34	-0.06	0.75	0.62	0.18

Table 4.7
Coefficient of Variance for Body Region Scores and Job Priority Score
By Scenario for the Alpha Test

Scenario #		SN Score	HWA Score	BT Score	LF Score	HE Score	Job Score
1	Mean	6.4	7.2	4.6	3.6	4.6	8.2
	CFVAR	0.422164	0.22821773	0.917175	0.697217	0.247864	0.180883
2	Mean	11	11.4	9	3	1	13.2
	CFVAR	0.272727	0.19218335	0.582672	0.62361	1.414214	0.24781
3	Mean	3.2	2.6	6.4	1.5	0	6.4
	CFVAR	0.40745	0.79755544	0.422164	0.745356	*	0.422164
4	Mean	4.2	1.8	2.4	2.8	0.8	4.4
	CFVAR	0.353152	0.248452	0.756913	0.465657	1.045825	0.259131
5	Mean	7.4	9	9.6	4.6	0.2	10.8
	CFVAR	0.280222	0.27216553	0.502813	0.423774	2.236068	0.40572
6	Mean	7.4	8.8	17	4.8	0	17
	CFVAR	0.311104	0.38030001	0.342997	0.64885	*	0.342997
7	Mean	7	5.2	5.8	3	0.2	8.2
	CFVAR	0.553283	0.34401046	0.970737	0.235702	2.236068	0.534363
8	Mean	6.8	4.2	8.8	3.8	0	9.8
	CFVAR	0.573341	0.31043821	0.697731	0.220174	*	0.565383
9	Mean	10.2	13.8	13.6	4.8	0.6	15.4
	CFVAR	0.127827	0.07938008	0.343312	0.400737	2.236068	0.218282
10	Mean	9	8.4	11.2	5	0.4	12.2
	CFVAR	0.260579	0.23206653	0.411102	0.374166	2.236068	0.297802

- Value is undefined when mean =0

Due to the broad confidence interval, the apparent improvement in agreement on the overall job rating can not be confirmed. Practical significance suggests that the reliability agreement is moderate, with chance corrected agreement rates between 0% and 75%. Table 4.8 presents the rate of consensus among ergonomists for body region ratings and job priority ratings. The data is organized by overall consensus (percentage of jobs where at least 80% of ergonomists assigned the same rating), consensus on jobs with for each priority ratings, and the consensus on jobs when medium and high priority ratings were pooled together. The results indicate that on 8 of the 10 jobs the ergonomists reached a consensus conclusion on job priority rating.

Table 4.8
Consensus Rates for Body Region Scores and Job Priority Score
Alpha Test Results

	Overall Consensus	Job Priority "High" consensus	Job Priority "Medium" consensus	Job Priority "Low" consensus	Job Priority "Medium or High" consensus
Job SN	40%	30%	10%	0%	80%
Job HW	50%	30%	10%	10%	70%
Job BT	40%	30%	0%	10%	70%
Job LF	20%	0%	0%	20%	30%
Job HE	100%	0%	10%	90%	10%
Job Overall	80%	70%	10%	0%	100%

Table 4.9
Agreement (Kappa) on Body Region and Overall Job Ratings
End-user Test Results

	Percent	Kappa	95%LCI	95%UCI
Job SN	0.39	-0.03	-0.15	0.10
Job HW	0.41	0.04	-0.09	0.17
Job BT	0.38	-0.02	-0.17	0.12
Job LF	0.29	-0.05	-0.14	0.04
Job HE	0.54	-0.03	-0.29	0.24
Job Overall	0.47	-0.01	-0.23	0.20

Table 4.10
Coefficient of Variance for Body Region Scores and Job Priority Score By Scenario for the End-user Test

Scenario #		SN Score	HWA Score	BT Score	LF Score	HE Score	Job Score
1	Mean	7.375	10.5	9.625	4.125	3.625	13.25
	CFVAR	0.54207	0.41042	0.62569	0.79286	0.5699	0.35111
2	Mean	9.125	9.375	8.875	5	1.5	10.375
	CFVAR	0.34871	0.50335	0.56639	0.42762	1.12687	0.40873
3	Mean	7.5	9	11.5	4.75	1.25	12.75
	CFVAR	0.54277	0.3849	0.4919	0.35138	1.26491	0.39717
4	Mean	5	5	4.25	4.25	1.875	6.625
	CFVAR	0.52372	0.54511	0.61293	0.39272	1.08321	0.30121
5	Mean	7.125	11.375	11.875	5.25	0.75	13.5
	CFVAR	0.60221	0.61257	0.63088	0.75335	1.98406	0.52974
6	Mean	8.625	7.375	12.625	5.25	0.625	13.875
	CFVAR	0.39165	0.28934	0.51843	0.71088	2.82843	0.3519
7	Mean	7.125	9.5	8.875	6.625	1.125	12.25
	CFVAR	0.52212	0.63657	0.50187	0.41875	1.45963	0.3258
8	Mean	9.25	7.75	12.125	5.5	0.875	12.875
	CFVAR	0.56839	0.89595	0.5371	0.45584	1.42448	0.55922
9	Mean	9.25	13	11.625	6.75	1.125	14.875
	CFVAR	0.43914	0.39007	0.59052	0.39396	1.20551	0.43037
10	Mean	8.5	7.375	12.125	4.625	0.75	12.5
	CFVAR	0.51474	0.62741	0.39291	0.48948	1.85164	0.39656

Table 4.11
Consensus Rates for Body Region Scores and Job Priority Score
End-user Test Results

	Overall Consensus	Job Priority "High" consensus	Job Priority "Medium" consensus	Job Priority "Low" consensus	Job Priority "Medium or High" consensus
Job SN	0%	0%	0%	0%	80%
Job HW	0%	0%	0%	0%	50%
Job BT	0%	0%	0%	0%	50%
Job LF	0%	0%	0%	0%	10%
Job HE	40%	0%	0%	40%	0%
Job Overall	0%	0%	0%	0%	70%

The end-user body part priority ratings and overall job ratings reflect the lack of agreement observed in the individual job factor questions. The agreement rate was 47%, (Kappa = -0.01, 95%LCI =-0.23, 95%UCI = 0.20). The consensus rates observed illustrate a similar lack of agreement. The lack of agreement on priority ratings is likely due to the lack of agreement on task selections and job factors.

4.2 CONTENT VALIDITY

There is a strong scientific basis for the inclusion of all the job factor questions present in this analysis. All job factor questions were derived from peer-reviewed journals, established technical books, or proposed standards. Each source has been identified as a potential WMSD risk factor and/or cause of localized fatigue and discomfort. The source documentation is provided in the Checklist Glossary contained within the Guide Supplement.

The list of job factor questions has been judged to be complete for warehousing and service tasks. At least 32 individual analysis methods were evaluated as a part of the literature review process. All risk factor-based questions identified in the 32 methods were considered for inclusion in order to insure that the list of job factor questions was complete.

The question/response structure (i.e., postural deviations or forces over a period of exposure) is based on a well-established model of how damage accumulates. Several existing analysis methods [12, 2] which use this basic model have been validated.

4.3 PRACTICALITY

The most significant aspect of the entire process is the effectiveness of the Guide Supplement in enabling the users to select the appropriate corrective actions. The measure of practicality used in testing focused on whether the Methodology could be applied and completed within the time guidelines established by the Air Force.

4.3.1 Usability

The end-users completed an usability questionnaire at the end of the test session. The usability questionnaire consisted of 20 questions with ratings on a five point Likert scale. These questions were grouped into three categories; answering the checklist questions, using matrices to identify solutions, and overall use of the Guide Supplement. The questionnaire is contained in Appendix B. Three questions on the scale were reversed (for example, disagree would be the desired response to "The tool is better suited to an ergonomist than a non-ergonomist"). In order to ease interpretation, the scoring of the reversed questions have been adjusted to match the other questions. The average responses for each question fell between 1.5 and 2.4, indicating that participants agreed with each usability statement. The statements that scored the most favorable were:

- The scores can be generated quickly and easily,
- The tool helps me to generate more solution options than I would have on my own,
- The scores can be clearly interpreted, and
- The activities performed in warehouse and service areas are covered in the tool.

The similarity of responses for each question suggests the responses may reflect an overall attitude towards the Methodology, rather than specific information about individual questions. With this in mind, it indicates that participants had a generally favorable opinion towards the Methodology.

4.3.2 Time Requirements

The time requirements for completing the analysis and for identifying and selecting control measures were calculated based on the End-user test sessions. The mean time for completing the Level I Checklist and scoring process was 23.0 minutes with a standard deviation of 13.4 minutes. The mean time for identifying and selecting control measures was 13.6 minutes with a standard deviation of 9.1 minutes. These values are well within the criteria established, indicating that this Methodology can be used quickly.

These times are within a standard deviation of the mean times obtained during Maintenance and Inspection Guide testing (Checklist mean = 16.6 minutes with a standard deviation of 10.8 minutes; corrective action mean = 12.0 minutes with a standard deviation of 7.4 minutes). This suggests that the time required to complete an assessment using the W/S Guide Supplement is similar to that required with the M/I Guide.

4.3.3 Selection of Corrective Actions.

The agreement on the selection of corrective actions was examined in two directions. First, the percentage of time in which a corrective action was selected by an End-user was compared to a consensus of ergonomists. Second, the percentage of corrective actions selected by the consensus of ergonomists was also selected by the End-users. It was determined that the straightforward agreement rates between the consensus of ergonomists and end-users would results in an inflated agreement based on non-selection of corrective actions, since most actions were not selected for any given scenario. The "consensus of ergonomists" in this and previous testing is represented by two factors:

- a majority of TJI/ADL ergonomists agreeing during the initial Alpha testing, or
- a minority agreeing in Alpha testing supplemented by subsequent discussions to produce a majority opinion.

The percentage of time the end-users selected corrective actions that were the same as the consensus was 45%. This indicates that of 100 corrective actions selected by end-users, 45 would have also been selected by an experienced ergonomist. While this is below the 61% agreement rate from the M/I Guide, it is better than would be expected based on the agreement on the Job Factors.

The percentage of time that a corrective action selected by the consensus of ergonomists was also selected by the End-user test subjects was 47%. This indicates that, on average, whenever the consensus ergonomist identified a solution, roughly four out of eight End-users would also have identified that same solution.

In the testing of all the guides, TJI/ADL has noticed that End-users were more likely to select solutions regardless of feasibility. The ergonomists appear more selective in identifying solutions. In actual use, this effect would likely be minimized by the involvement of multiple base personnel working to implement a solution.

The agreement on solutions was likely reduced from previous testing efforts due to the lower agreement between end-users on job factor identification. Since corrective action selection is driven by the identification of job factor presence in the case study matrices, a reduction in agreement at the job factor level would be likely to result in a decreased agreement on corrective actions.

5.0 CONCLUSIONS

The results of the validation process provide evidence of the validity, reliability, and practicality of the Methodology. The results are summarized below.

5.1 VALIDITY

All of the job factor questions were supported by scientific research. The list of job factor questions was inclusive of the Job Factors that commonly occur in warehousing and service area tasks.

The overall theoretical framework of the checklist was a logical structure used in assessment tools that have been validated. The checklist framework is also consistent with the Level I Methodologies for Administrative and M/I Work Areas.

The corrective actions selected by the end-user agreed with the solutions selected by a consensus of ergonomists between 45% and 47% of the time. This is lower than the agreement rates obtained in testing previous guides. This reduced solution agreement is likely the result of decrease inter-rater agreement on the Job Factor questions. Since the corrective actions are organized by Job Factors, users must first agree on the identification of job factors before corrective action agreement can occur. In spite of the reduced agreement, the results suggests that the W/S Guide Supplement assists end-users in generating solutions that experts would recommend.

5.2 RELIABILITY

The agreement between ergonomists during Alpha testing of the W/S Guide Supplement (59%, Kappa = 0.24) was nearly identical to the Alpha test agreement from the M/I Guide (64%, Kappa = 0.29). This is consistent with expectations, since the checklist tools are highly similar.

The reliability results from the End-user testing did not meet expectations. The agreement results were considerably lower than those obtained during W/S Guide Supplement Alpha testing and the M/I Guide beta testing Post hoc investigation of these results suggests that a combination of factors contributed to the decreased agreement among end-users in the testing of the W/S Guide Supplement, including:

- The amount of training provided for the W/S Guide Supplement End-users was, by design, less than that provided for the M/I Guide beta test subjects;
- The end users added tasks to the lists provided in the W/S Guide Supplement case studies and test scenario;
- There were fewer end-users participating in the test than planned; and

- Many times, the End-users chose not to view the videotape while completing the checklist.

As a result of these factors, PES and TJI/ADL does not consider results of the End-user test to accurately reflect on the reliability of the W/S Guide Supplement. The fact that the results of the Alpha test are nearly identical to the Alpha test results from the M/I Guide, combined with the similarities in the Level I Checklists for these two tools, suggests that the performance of this Guide Supplement is similar to previous guides. PES and TJI/ADL believe that additional End-user testing of the W/S Guide Supplement would not likely add appreciable value to the reliability or validity of the W/S Guide Supplement. Beta testing of previous Guides validates both the checklist design and the pattern matching process that are used in the W/S Guide Supplement.

5.3 PRACTICALITY AND USABILITY

The Methodology received favorable usability comments and was well accepted by BEF test subjects. The usability ratings for the W/S Guide Supplement are consistent with previous results. Each question rating had an average between 1.5 and 2.4 on a scale from 1 to 5, with scores of 1 indicating the most positive response. These scores indicate that participants had a generally favorable opinion towards the Methodology. While the W/S Guide Supplement End-user testing had an expanded usability evaluation component from the M/I Guide beta testing, the results are similar. The ratings for the M/I Guide beta test ranged from 1.8 to 2.3.

The W/S Guide Supplement met and improved on the "time for completion" requirements established by the Air Force. The mean time for completing the Level I Checklist and scoring process was 23.0 minutes with a standard deviation of 13.4 minutes. The mean time for identifying and selecting control measures was 13.6 minutes with a standard deviation of 9.1 minutes. The original criteria provided by the Air Force was 1 to 2 hours for data collection and analysis, with an additional 1 to 2 hours for control identification.

5.4 SUMMARY

In summary, the primary strengths of the Guide are:

- it is easy to use;
- it has shown good acceptance by the most likely end-user population (BEF technicians);
- it meets and improves on the "time for completion" requirements established by the Air Force; and

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APPENDIX A

Ergonomists' Qualification Summaries

Biography

Richard Barker
Certified Professional Ergonomist (CPE)
Arthur D. Little

Mr. Barker, MA, CPE is a manager with Arthur D. Little, within the Environmental, Health, and Safety Division. Mr. Barker has been an ergonomics consultant since 1991.

Assembly and Manufacturing

- For an United States Air Force depot maintenance facility, Mr. Barker performed an ergonomics assessment of 30 engine and engine component repair workstations. Based on the risk factors identified, Mr. Barker proposed a range of corrective actions for each workstation. After workstation changes had been implemented, he returned to document the health, quality and productivity benefits associated with the ergonomic improvements. Mr. Barker trained personnel at this base to perform basic and advanced ergonomic assessments. (1996-1998)

- For GE Aircraft Engine, Mr. Barker conducted training courses in ergonomics for design engineers in Support Equipment Operations. These courses focused on the practical application of ergonomics guidelines to the design of fixtures and tooling. In the test engine development area, Mr. Barker performed an ergonomics assessment of 300 carts, classified into over 100 types and variants. He identified a priority for making handle design and wheel selection interventions. For those carts requiring new handle designs, Mr. Barker identified design concepts and worked with other engineers to develop design drawings and prototypes. (1997)

- For a manufacturer of hydraulics products, Mr. Barker provided ergonomics assessment and training services. Mr. Barker performed an overview assessment of the entire operation through a combination of injury/illness records review, employee interviews and direct observation. Based on this information, he identified work areas with both high priority and high opportunity for intervention for additional assessment and recommendation development. Mr. Barker developed short-term and long-term recommendations for workstation improvement for each job identified. Mr. Barker provided training for plant personnel in the identification of ergonomics hazards. (Sun Hydraulics, 1997)

- For a manufacturer of commercial fuse and electric products, Mr. Barker has conducted an ergonomics evaluation of one fuse assembly and packaging line. As a result of this evaluation, he identified changes in the workstation designs that could reduce exposure to ergonomics hazards. (S & C Electric, 1997)

- For a manufacturer of rice cakes, Mr. Barker provided process and tool modification recommendations to reduce exposure to ergonomics hazards in the cake popping molds area. These recommendations included specific product suggestions for off-the-shelf products and detailed design specifications for custom manufactured tools. Mr. Barker met with contract tool engineers to discuss the suggested modifications. (Quaker Rice Cakes, 1996)

- For the machining and assembly divisions of an axle, brake and transmission manufacturer; Mr. Barker analyzed workstations and ranked them according the potential for ergonomics injury. He then made workstation design, tooling selection and process change recommendations to reduce the risk of injury. He provided ongoing support to project engineers in the workstation redesign, cost justification and implementation processes. Mr. Barker conducted training at multiple facilities within the automotive products division. He held sessions for managers outlining the business case for ergonomics intervention within their facilities. Engineers, safety personnel, medical personnel, and members of the ergonomics steering committee were trained in hazard identification, risk prioritization, solution development, and solution evaluation. Area teams composed of production employees coordinated by the area engineers were trained to identify ergonomic risks and propose low-cost solutions. (1992-1994)

- Mr. Barker reviewed the ergonomics program for a motorcycle engine assembly facility. Based on this program assessment, he suggested specific changes to the written ergonomics plan and implemented a plant-wide ergonomics training strategy. Mr. Barker worked with client representatives to develop site specific training materials and risk assessment tools. The resulting training course is required for all incoming manufacturing engineers, supervisors, union safety representatives and union stewards. (Harley Davidson, 1994-1998)

- Mr. Barker trained joint management-union ergonomics committees at over 30 automotive assembly and components facilities in ergonomics hazard evaluation and in the development of injury prevention strategies. As part of these site-specific training sessions, Mr. Barker conducted ergonomic hazard assessments and developed corrective action recommendations at each facility to serve as models for course participants. (1992-1994)

- Mr. Barker provided ergonomics design support to the engineering department for several foundries. He recommended short- and long-term alternatives for both current operations and proposed new areas. The potential reduction in ergonomic risk was quantified for each recommendation. (Ford, Chrysler, GM, 1991-1994)

- For a manufacturer of extruded plastic automotive components, Mr. Barker assessed the potential impacts of job changes proposed by plant engineers. He analyzed jobs to determine the potential for return-to-work or alternate duty classification. (1993)

- For a manufacturer of truck engines, Mr. Barker reviewed the assembly operations to identify ergonomics hazards and provide recommendations. He also trained the joint management-union ergonomic committee in hazard identification and recommendation development. (Navistar, 1995)

- For a medical products manufacturer, Mr. Barker assisted plant and corporate engineers in the clean sheet design of a facility by analyzing current operations and developing design alternatives. The project included workstation design, plant layout, part transfer and manpower loading components. Mr. Barker also provided recommendations for workstation modifications at additional facilities within the U.S., U.K. and Mexico. (1991-1994).

- Mr. Barker has conducted site specific training for engineers and members of ergonomics committees focusing on hazard identification, solution development and ergonomics committee structure for a wide variety of industries including defense contractors, paper products, lumber and wood pulp products, beverage bottling, food, chemical, rubber and tire, steel, electronics, plastics, fiberglass and automotive parts. (including Freightliner, GE Plastics, Lukens, Motorola, Quaker Oats Company, Seagram, Yokohama, 1991-1997)

Forensics

- In an arbitration involving a union claim that the employer was staffing at unsafe and unreasonable levels, Mr. Barker performed assessments to identify the frequency of ergonomics stressors. These stressors were compared to guidelines drawn from the research literature in order to identify the impact that staffing level and work rates might be having on the employees. (1997)

- In a case filed under the Americans with Disabilities Act, Mr. Barker compared the physical demands associated with the job to the work restrictions and capabilities of the plaintiff. (1997)

- In response to an OSHA investigation, a manufacturer of hand-made specialty products requested an independent ergonomics assessment and recommendations for workstation and process improvement. Mr. Barker performed the assessment, developed recommendations and prepared a report documenting the findings. (1995)

- In support of a Cal-OSHA abatement process, Mr. Barker has provided work station design recommendations for a fruit packaging operation. (1993)

- In support of an OSHA abatement agreement at a meatpacking facility, Mr. Barker provided evaluations and redesign recommendations. Mr. Barker also assessed work areas for potential alternate duty or return-to-work placement. (1992)

- In support of an OSHA abatement agreement for an automotive manufacturer, Mr. Barker provided worksite assessments and ergonomics training for joint union-management committees. (1991-1993)

Packaging and Shipping

- For a manufacturer of cartridge razors, Mr. Barker performed a review of 3 proposed packaging lines. This review included the identification of likely ergonomics hazards and proposed recommendations. He performed the review based on blueprint drawings, sample product packages and observation of similar packaging lines. (Gillette, 1997-1998)

- For a manufacturer of cabinets, Mr. Barker suggested workstation, equipment and process improvements for the palletizing and loading truck operations. (Fisher Scientific, 1996)

- For a manufacturer of cosmetics, Mr. Barker developed design guidelines for inspection, card loading and cartoning workstations. These design guidelines were incorporated into training courses for the company's process and manufacturing engineers. Mr. Barker also prepared an ergonomics assessment and suggested workstation improvements for a pick tunnel operation in this facility's shipping area. (1994)

- For a facility which warehouses oil and lubrication products, Mr. Barker identified workstation improvements for the product picking operations. He quantified the ergonomics risk factor exposure associated with task and provided estimated benefits for each recommendation. (1994)

- For an automotive parts distribution warehouse, Mr. Barker performed ergonomics assessments of carousel parts loading, carousel parts picking, small parts packaging and order picking for storage shelving. These assessments identified the risk factors present and recommendations to reduce exposure to these risk factors. Mr. Barker also trained ergonomics team members in hazard identification and solution development. (1994)

Product Development and User Testing

- For a check processing company, Mr. Barker evaluated the impact of workstation changes on the comfort and performance of computer-based data entry operators. This research resulted in specific design and vendor recommendations. Mr. Barker developed research plans, conducted experiments, performed statistical analyses, interpreted data, identified recommendations, produced reports, and presented results in support of the development of image check processing equipment. This research involved subjective and performance measures of potential products and benchmarking operator performance on competitors' products. Mr. Barker provided product development support including participation on interdisciplinary design teams regarding hardware and software development. Programs supported include software, computer hardware, check sorting equipment interface, and manufacturing. (Unisys, 1991).

- For the USAF ergonomics assessment methodologies, Mr. Barker developed research plans for testing the usability and validity of the paper based tools. He conducted focus groups,

usability surveying, field testing and controlled testing in support of this research agenda. (USAF, 1995-1997).

- Mr. Barker focused on product design and end-user methods for a parts supplier for a consumer products manufacturer. He authorized the work meeting for producing a video on how to use their product. (1994-1995).

- Mr. Barker conducted, as a graduate assistant, experimental trials and performed statistical analyses for research projects in discrimination of subjective scaling response categories, comparative performance of subjective mental workload assessment methods and pilot simulator performance with varying control configurations. Mr. Barker's Masters thesis was conducted on the potential effects of the laboratory environment on the outcome measures of software usability testing. (University of Dayton, 1987-1989).

Education

Mr. Barker received a Masters degree in Human Factors from the University of Dayton, in Ohio. Mr. Barker is a Certified Professional Ergonomist.

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Marcotte, A., **Barker, R.**, Joyce, M. et al (1996) *Preventing Work-Related Musculoskeletal Illnesses Through Ergonomics: The Air Force PREMIER Program Volume 2: Job Requirements/Physical Demands Survey Methodology Guide*, United States Air Force Space Command/Armstrong Laboratories, DTIC number: AD-A325512.

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Barker, R. T. "Developing an Ergonomics Program for CTS & Tendonitis," *Manufacturers' Education Council*, Columbus, OH, February 1995.

Barker, R. T. "Writing and Implementing an Ergonomics Plan -- Professional Development Course," *American Society of Safety Engineers*, Chicago, IL, November 1994.

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Barker, R. T. "The Ergonomics of Material Handling," *The Norton Company Annual Corporate Safety Meeting*, April 1994.

Barker, R. T. "A Strategy for Implementing Ergonomics," *Industrial Health Foundation Annual Scientific Meeting*, Pittsburgh, Pennsylvania, May 1993.

Barker, R. and Nadel, J. (1991) A research strategy for investigating the ergonomics risks associated with computer input devices, *The Office Related CTD Research Committee.*

Biography

Van C. Calvez, CPE
Ergonomist/Human Factors Engineer
The Joyce Institute/A Unit of Arthur D. Little

Mr. Calvez, MS, is an ergonomist/human factors engineer with The Joyce Institute, a unit of Arthur D. Little, within the Environmental, Health, and Safety Directorate. He provides consulting and training, ergonomics program development expertise to a variety of industrial, health care, and office clients. Mr. Calvez also has special expertise in product design and traditional human factors.

Human Factors Design

- Analyzed and developed recommendations for air traffic controllers as part of United States Air Force contract for Materiel Command and Space Command.

- Analyzed and provided design input for command/control centers for the baggage handling system for a major airport.

- Researched and developed the proprietary methodology *Human Information Processing Protocol* and applied it to control/display design, decision making, error and cognitive task analysis, design of presentation of information to minimize errors, error-resistant systems, and error-tolerant systems.

- Completed an extensive literature search to identify ergonomics/human factors related issues for the Air Force.

- Analyzed and provided input into the design of the workplace to minimize the impacts of fatigue in vigilance tasks.

Product Design/Human Factors

- For a major computer components manufacturer, Mr. Calvez performed a human factors evaluation of manufacturing equipment in order to identify hazards for catastrophic accidents related to the human-machine interface. He used a task analysis method based on human information processing capabilities to structure operator comments and identify aspects of the machine design which encouraged or permitted operator errors.

- Mr. Calvez conducted usability tests and an ergonomics evaluation of a consumer product to determine if the product concept meets user requirements. An ergonomics evaluation of the product concept was completed to determine if the use of the product would contribute to cumulative stress to the hand. Usability tests were examined if the product concepts matched user expectations of how the task should be performed. The results were used to modify the product design to reduce cumulative stress and improve consumer satisfaction with the product.

Industrial Workplace Consulting: Ergonomics Assessment and Design

- For the publisher of a large metropolitan newspaper, Mr. Calvez provided a comprehensive identification and prioritization of production tasks which have contributed to manual handling injuries. He also made practical recommendations to assist the client in focusing problem solving efforts, and worked with personnel to develop cost-effective solutions.

- At a components warehouse, Mr. Calvez recommended modifications to a receiving area to eliminate awkward lifting postures, unnecessary transfers, and wasted effort. The overall efficiency of the operation was increased.

- For a munitions manufacturer, he performed ergonomics analyses of machining and assembly tasks. He also provided recommendations for modifications of equipment and work areas to eliminate ergonomic hazards.

Health Care/Laboratory Consulting

- For a large hospital, Mr. Calvez completed an ergonomics evaluation of handling tasks performed within a surgical processing department. He provided recommendations for the rearrangement of equipment to increase workspace, increase storage capacity, improve departmental efficiency, and eliminate hazardous handling tasks.

- Mr. Calvez provided a health care product manufacturing company with ergonomics expertise and direction during the development of a training video for a patient handling product. He provided assistance during the shooting of the video to ensure the best ergonomic use of the product, and evaluated the resulting video to ensure that appropriate procedures were clearly described and presented.

- Mr. Calvez conducted detailed ergonomic analyses of tasks performed in a laboratory. He collected workstation measurements, videotapes, and employee comments; and completed elemental task analyses, postural analyses, and biomechanical analyses. Results of the analyses and his recommendations provided the bases of support for an ergonomics program.

Office Workplace Consulting: Ergonomics Assessment and Design

- For a regional utility, Mr. Calvez conducted an ergonomics evaluation to determine the potential cause of ergonomic stressors in the cash processing department. His recommendations included increased lighting, modifications to workarea layout, and minor modifications to work task procedures.

- Mr. Calvez developed specifications for office/computer furniture, chairs, and accessories at the corporate offices of an insurance company. Workstation specifications were based on ergonomics principles, relevant tasks performed, and workplace constraints. The client was provided with specific recommendations for modifying current furniture to meet ergonomics requirements.

Training Design and Implementation

- Mr. Calvez provided advanced ergonomics training to engineers at a printing products company, with primary emphasis on an injury-causing picking task. Excessive disc forces were measured as a part of the task. The lifting task was converted into a sliding task through the use of a rake device. Excessive lifting tasks were eliminated and picking efficiency was increased.

- For an automotive products firm, he provided advanced ergonomics training for engineers and safety representatives, which involved developing solutions for high risk tasks and implementing prototype solutions.

- At a major metropolitan newspaper, Mr. Calvez conducted training for facilities personnel, managers and supervisors enabling them to make modifications to existing offices, create design guidelines and establish criteria for furniture, accessories and equipment.

- He trained managers and supervisors at a transportation company in problem identification techniques through the use of an Ergonomics Checklist. Upon completion of training, supervisors and managers were able to provide recommendations for minimizing or reducing ergonomic stressors.

- For a major consumer products manufacturing company, Mr. Calvez provided customized ergonomics training for both the manufacturing and office environments. Training provided for industrial and design engineers, safety personnel, facilities personnel, supervisors and employees. Mr. Calvez also assisted ergonomics teams with measuring the impact of changes implemented after the training.

- For a large defense/electronics company, he provided customized ergonomics training for representatives of several divisions of a large corporation. Provided guidance to facilitate the development of ergonomics efforts at individual sites.

- For a financial services company, Mr. Calvez provided ergonomics training for the office environment of a large investment firm. Ergonomics training was provided for facilities personnel, safety, departmental representatives, and employees.

Previous Experience

- Prior to joining The Joyce Institute, Mr. Calvez was employed as a human factors researcher/product engineer with Fitch Richardson Smith/Polymer Solutions, Inc. In that capacity, he performed ergonomics analyses to specify product features to meet the capabilities and limitations of the user. He also supplied design engineering for product components and assemblies, and provided design-focused user and market research for consumer products, consumer electronics, medical products, and lawn & garden products. He employed configurable product models to involve clients and users in the design process.

- Prior to that, Mr. Calvez was a project engineer/industrial engineer with Worthington Custom Plastics. He designed manufacturing equipment, hand tools, work tables and material dispensers; and modified product designs to improve quality and manufacturability. He also performed ergonomic evaluations and time/motion studies of operator workstations, and implemented improvements to paint mask operations which increased worker satisfaction and substantially reduced cycle times.

- As a researcher, he developed a computer-based technique for obtaining a user's mental model of a technical domain. He also developed and tested the usability of software and documentation for thesis research.

Education

Mr. Calvez received Master of Science and Bachelor of Science degrees in Human Factors Engineering from Wright State University in Dayton, Ohio.

He is a member of the Human Factors and Ergonomics Society and Tau Beta Pi, the Engineering Honor Society. He received a Research Fellowship from the Office of Naval Research, and was named Outstanding Graduate Student in Human Factors Engineering by Wright State University. He became a Certified Professional Ergonomist (CPE) in 1995.

Presentations

Calvez, V. "Job-Specific Ergonomics Training," VPPPA Conference, Washington, DC, September 28, 1995.

Calvez, V. "Implementing Ergonomics in the Laboratory Environment," 11th Annual Laboratory Safety and Environmental Conference, Baltimore, Maryland, June 26-29, 1995.

Calvez, V. "Ergonomics: Overview of Proposed Regulations," prepared for Gillette Environmental / Safety Meeting, Newport, RI, May 18, 1994.

Calvez, V. "Application of Methods from the Proposed ANSI Standard for the Control of Cumulative Trauma Disorders," American Industrial Hygiene Association (AIHA), Anaheim, CA, May, 1994.

Calvez, V. Presented to the New Jersey Public Service Electric & Gas, April, 1994.

Calvez, V. "Applying Ergonomics in the Health Care Environment," presented to The Hospital Employee Health Director's Association of Greater New York, January 26, 1994.

Calvez, V. "The New OSHA Ergonomics Standard," presented to The Hospital Employee Health Director's Association of Greater New York, January 25, 1994.

Calvez, V. "Ergonomic Applications in the Health Care Industry," Lenox Hill Hospital, New York, New York, July 14, 1993.

Biography

Jeffrey B. Nelson, CPE
The Joyce Institute/A Unit of Arthur D. Little

Mr. Nelson, MSIE, is a consultant for The Joyce Institute/A Unit of Arthur D. Little specializing in industrial and office consulting and training and in the design of consumer products for industrial and home environments. He has extensive experience in office product manufacturing, automobile assembly, semiconductor and clean room environments, and the chemical and consumer product industries.

Industrial Workplace Consulting: Ergonomics Assessment and Design

- For a modular housing fabricator in Mexico, Mr. Nelson designed a "super jig" for use in the construction of modular housing, and evaluated and critiqued the prototype of the machine.

- For a major hospital, he evaluated the stresses caused during plasma vial inspection. His recommendations included the redesign of a new "reject" holding cart, the adjustment of a lighting screen, the relocation of task lighting, the implementation of a worker rotation procedure, and the balancing of line speeds.

- For a corrugated box manufacturer, Mr. Nelson identified the stressors placed on workers involved in a box assembly procedure. He recommended process improvements and equipment modifications, including the relocation of controls, scheduled employee rotation, and the purchase of manual lifting devices. He also recommended the purchase of automated folding equipment, and created a design for a stationary folding apparatus.

- For a consumer products manufacturer, he evaluated a rotational molding operation, and recommended process revisions as well as design modifications for the working platform, the material delivery system, several tools and molds.

- For a sewage disposal facility, Mr. Nelson identified the musculoskeletal stressors placed on workers involved in the transfer of motor oil between containers. He recommended the purchase of a manual siphon pump to eliminate static loading on the shoulder, which was occurring during the performance of several tasks.

- For a snack foods manufacturer, Mr. Nelson identified the sources of musculoskeletal stressors placed on workers involved in the hand packing and box construction processes. Additionally, he was asked to identify those benefits which would be gained with the implementation of further ergonomics based improvements. Mr. Nelson recommended the installation of a mechanized box maker and label applicator, the addition of a height-adjustable table between two conveyor lines, and the height and weight constraints for the mylar packaging rolls. He also recommended modifications to the job rotation, and indicated the potential risk with changes in line speed.

- For the U.S. Air Force-Material and Space Command, Mr. Nelson served as the "Gold Standard Ergonomist" during the task evaluation and recommendations phases. During his lengthy visits to USAF bases in Massachusetts and Florida, he identified and ranked those tasks which contained large amounts of musculoskeletal stressors. Additionally, for each identified task, he devised engineering-based solutions to alleviate those stressors.

- For the U.S. Postal Service, Mr. Nelson evaluated the mechanized bulk mail sorting/delivery operation. He recommended lighting adjustments for all tasks, provision of anti-fatigue matting, adjustment of keypad features for workers at standing workstations, creation of a company-wide job/worker rotation policy, workstation redesign to facilitate movement and enable the use of both hands, substitution of manual keypad entry with a bar-code reading system, and the purchase of headsets and adjustable chairs for control room monitors. He also recommended the incorporation of advanced ergonomics analysis techniques into future design.

Office Workplace Consulting: Ergonomics Assessment and Design

- For a regional hospital, Mr. Nelson recommended improvements to the Critical Care, Histology and Transcription Departments. His recommendations resulted in the redesign of work areas for enhanced visibility, alleviation of psychosocial stresses and increased desk space. He also recommended the automation of certain activities to reduce stresses to the upper limbs and remove external trauma; and recommended the development of policy covering workload distribution, workstation layout and materials placement.

- For a hospital, Mr. Nelson redesigned a medical records storage facility. His recommendations included the installation of new equipment and the redesign of out-patient records facility.

- For a large technology firm, Mr. Nelson developed a manual that instructs computer input device users in how to improve their workstation layout, body orientation and work habits by incorporating ergonomics principles. For the manual, he created a customized checklist to reinforce these principles on an ongoing basis through the use of exercises and strategies to increase comfort.

- For a railway management office where there had been workplace injuries, he identified stressors and recommended improvements including the equipment purchase, institution of formal evaluation procedures, redesign of work areas and suggested design for future space planning efforts, training in office ergonomics.

- Mr. Nelson evaluated physical and psychosocial issues involved with an aerospace-industry office worker who had been diagnosed Fibromyalgia. His recommendations included workstation redesign and enhancements, education about Fibromyalgia, broadening of the worker's job to include greater responsibility and variety of tasks, and training in office ergonomics.

Product Design Criteria Development for End-User

- For a multinational computer design firm, Mr. Nelson developed design and operational criteria to be used in the development of a computer input device. The criteria will allow for movement/control in all planes and force feedback without causing potential injury.

Training Design and Implementation

- For the U.S. Postal Service, Mr. Nelson developed and implemented customized ergonomics course material, addressing those ergonomics stressors for tasks involving sitting, standing and materials handling.

- Mr. Nelson has trained employees in ways to identify, alleviate and prevent workplace ergonomics hazards at numerous industrial and office firms, including a chemical manufacturer, an electrical component/semiconductor manufacturer, an electronic test equipment manufacturer, a hospital equipment manufacturer, newspaper printing and publishing companies, manufacturers of office, vinyl and paper products, an international petrochemical company, a major pharmaceuticals firm, a pulp and paper processor, a seafood processor, a manufacturer of silicon wafers, a truck manufacturer and a wood and steel cabinet construction firm.

Education/Professional Activities
Mr. Nelson received a Master of Science in Industrial Engineering, specializing in Industrial Ergonomics, from the University of Cincinnati in Ohio. He holds a Bachelor of Science in Kinesiology, specializing in Biomechanics, Neurology and Physiology from the University of California at Los Angeles.

He is a member of the Human Factors and Ergonomics Society and the American Society of Safety Engineers.

Publications
Nelson, Jeffrey B. and Anil Mital, "An Ergonomical Evaluation of the Primary Hand Flexibility and Capability Changes with Increases in Examination/Surgical Glove Thickness," *Ergonomics*, Vol. 38, No. 4, April 1995.

Presentations
Nelson, J. B. and Joyce, M. "Measuring the Results of Ergonomics Training," ErgoCon, San Jose CA, May 1995.

Nelson, J. B., and Joyce, M. "Computer Related Injuries: Ergonomics and OSHA Guidelines," Society of Architectural Administrators, Los Angeles CA, May 1994.

Nelson, J. B. and Joyce, M. "Ergonomics," Western Safety Congress, Anaheim CA, May 1994.

Biography

Linda Martin, M.E. Des.
Human Factors Engineer/Ergonomist
The Joyce Institute / A Unit of Arthur D. Little

Ms. Martin is a human factors engineer/ergonomist with The Joyce Institute, a Unit of Arthur D. Little, within the Environmental, Health, and Safety Directorate. Ms. Martin provides ergonomics consulting, training, and planning services to a variety of industrial, office, and health care clients

Ergonomics Training Design and Implementation

Ms. Martin has assisted organizations with integrating ergonomics principles into design processes and management systems. She has provided ergonomics training in a variety of industries at all levels; including frontline workers, engineers, and organizational leaders. She has developed and presented ergonomic training for office/computer, manufacturing, maintenance, resource based industries (forestry, oil & gas and mining), health care and laboratory environments. The following are examples of prior ergonomics training services:

- Provided customized ergonomics training in both the industrial and office environments for a number of forestry companies. Ms. Martin provided training for process engineers, design engineers, EHS personnel, supervisors, and employees. EHS personnel learned how to conduct ergonomics assessments of work areas and develop short-term solutions based on ergonomics principles. Engineers learned how to design work stations and manufacturing processes to eliminate ergonomic risk factors and improve productivity. Supervisors and hourly employees learned how to identify risk factors and make minor adjustments in workstations and procedures. Ms. Martin also assisted ergonomics teams in implementing solutions and measuring the impact of results.

- Developed customized ergonomics training for a telecommunications company. Ms. Martin worked with the client to developed ergonomics training package which was customized for field utility applications. Customized content and illustrations were based on ergonomic field studies at various field sites. She designed the training materials and train-the-trainer modules. She then trained field representatives in conducting ergonomics assessments and developing solutions. She also provided them with the skills and materials required to be internal trainers.

- Developed customized ergonomics training for a City Corporation of 21,000 employees. Ms. Martin worked with the client to developed training materials which were customized to meet their needs. Illustrations were based on ergonomic field

studies at various production sites. Her presented the completed training course to managers and supervisors as well as a train-the-trainer course.

- Developed a customized ergonomics program for a City Corporation and Workers Compensation Board. Ms. Martin worked with the clients to strategically plan a ergonomics plan, budget process and roll out package for the organizations.

Ergonomics Assessment and Design

Ms. Martin has provided ergonomics consulting for a variety of clients in resource based industries specifically forestry, health care, laboratory, and office environments. Much of this work has focused on improving process efficiency, improving product quality, and preventing work-related fatigue and musculoskeletal disorders (such as back injuries, carpal tunnel syndrome). Ms. Martin's work ranges from identifying and prioritizing ergonomic hazards in entire facilities to providing engineering assistance with the development of new tools and equipment. The following are some examples of this type of work in three major areas: industrial, health care/laboratory, and office workplaces.

Industrial Workplace Consulting

The following are examples of ergonomics consulting activities in resource based industries environments:

- Recommended equipment and process modifications for natural gas company in the meter repair and shipping and receiving to eliminate repetitive motions, heavy lifting and examine flow patterns. By rearranging the receiving department and manual handling equipment it was possible to eliminate a large amount of unnecessary manual handling

- Identified and prioritized high risk production tasks for a lumbermill. Ms. Martin reviewed existing injury records and conducted an ergonomics assessment of all production activities. She then made recommendations to assist the client in focusing problem solving efforts, and worked with personnel to develop cost-effective solutions.

- Performed ergonomics analyses of saw filing shop, wrap and strapper and handling system in a lumbermill. She also provided recommendations for modifications of equipment and work areas to eliminate ergonomic hazards.

Office Workplace Consulting

The following are examples of ergonomics consulting activities for office/computer tasks:

- Developed specifications for office/computer furniture, chairs, and accessories at the corporate offices of an Telecommunications company. Workstation specifications were based on ergonomics principles, relevant tasks performed, and workplace constraints. The client was provided with specific recommendations for modifying current furniture to meet ergonomics requirements.

- Conducted an ergonomics evaluation to determine the potential cause of ergonomic stressors in the cash processing department for a regional utility. She recommendations included increased lighting, modifications to work area layout, and minor modifications to work task procedures.

Health Care/Laboratory Consulting
The following are examples of ergonomics consulting activities in health care environments:

- Completed an ergonomics evaluation of handling tasks performed within a surgical processing department for a large medical center. Ms. Martin provided recommendations for the rearrangement of equipment to increase workspace, increase storage capacity, improve departmental efficiency, and eliminate hazardous handling tasks.

- Conducted detailed ergonomic analyses of tasks performed in a laundry and kitchen service within a hospital. She collected workstation measurements, videotapes, and employee comments; and completed elemental task analyses, postural analyses, and biomechanical analyses. Results of the analyses and her recommendations provided the bases of support for an ergonomics program.

Education
Ms. Martin received Master of Environmental Design from the University of Calgary and Bachelor of Science degrees in Rehabilitation Medicine from University of Alberta. She is presently working on a Ph.D. in Environmental Design at the University of Calgary.

She is a full member of the Human Factors Association of Canada and the Canadian Association of Occupational Therapists. She was runner up for the Gold Medal at the University of Calgary for her graduate research work.

Partial Client List
Telus Communications Inc.
Ranger
Northwestern Utilities Ltd.
Canadian Western Natural Gas
Altasteel
Hewlett Packard
Capital Health Authority
City of Calgary

Biography

Andrew J. Marcotte, MS, CPE

Mr. Marcotte is the Assistant Director of Ergonomics for The Joyce Institute unit of Arthur D. Little. Mr. Marcotte is responsible for planning, managing, and providing technical direction and on-going support for large ergonomics projects. His current work involves helping clients identify innovative approaches to implementing ergonomics programs including priority-based worksite analysis, practical solution design, and ergonomics specification development for future installations/purchases, which generate results that show measurable improvements in employee health and safety, workers' compensation costs as well as company performance and profitability. Together with the ergonomics consulting staff, Mr. Marcotte has designed a series of training courses for addressing ergonomics concerns in industrial, maintenance and service, administrative, laboratory, and health care environments as well as integrating ergonomics into the product development cycle.

Relevant Professional Experience

- Mr. Marcotte served as the technical project manager for a $1.2 MM contract with the United States Air Force. Project goals included developing a systematic approach to worksite analysis and hazard prevention and control and implementing that system as a model for continued application by Air Force personnel. The system uses a multi-tiered approach to problem identification that identifies and prioritizes potential problem departments based on past injury illness reports and a Job Requirements and Physical Demands Survey. The next step uses a risk factor checklist to identify problem-solving priorities for jobs within the problem departments. Sixty solution design Case Studies have been created to address common ergonomics problems associated with (aircraft and systems) maintenance and inspection, assembly, warehousing, and administrative work tasks. Mr. Marcotte's project responsibilities included developing the project workplan, developing the models for data collection, Survey, Checklist, and Case Study design, drafting ongoing status and the final project reports, and acting as a technical liaison with Air Force program managers during implementation and program success measurement.

- Mr. Marcotte developed ergonomics program Guidelines for a large aerospace conglomerate. Mr. Marcotte, integrated ergonomics into existing corporate safety and health policy, developed a Guidance Document which identifies individual company responsibilities and drafted a "model" ergonomics implementation strategy which could be used throughout the organization as the basis for site-specific program planning and implementation.

- Mr. Marcotte's work with a national office products manufacturer has resulted in 1.7 million in cost savings over a 2.5 year period. Mr. Marcotte was responsible establishing the original strategy document (written ergonomics plan) which specified the systematic integration of ergonomics analysis and design methodologies into the organizations day to day operations and continuous improvement processes. His other responsibilities included: conducting worksite analysis and establishing initial priorities for improvement; identifying short- and long-term solutions to priority ergonomics problems; providing all technical training for committees and personnel who had impact on the way that jobs and the workplace are designed; measuring results; and working with the company to develop "best practices" that are now used as technology is transferred throughout the organization.

- Mr. Marcotte provided technical expertise to a large aerospace/fuel systems company. His expertise was used to ensure that a change to cell manufacturing technology would minimize employee exposure to ergonomics hazards, improve material flow, and maximize cell productivity. Mr. Marcotte also used the recommendations (e.g., analysis results, priority list, solutions and implementation strategy) to train engineers and manufacturing personnel to enable them to address other common ergonomics issues throughout the facility.

- Mr. Marcotte performed a series of workplace assessments at the request of a missile systems manufacturer. The ergonomics assessment was prompted by union officials due to past employee complaints and a concern about cumulative trauma injuries. The assessment results were used by the union and management to identify a list of action priorities for implementing improvements throughout the facility. Processes included wiring harness assembly, soldering/bench work, metal fabrication, component assembly, visual inspection, and heavy material handling.

- Mr. Marcotte provided technical review to a major helicopter manufacturer, Bell Helicopter, to maximize the effectiveness of solutions provided for all primary work functions associated with helicopter assembly. He also developed the company's ergonomics training manual and course structure for a Self-Paced supervisor and employee seminar which is used on an on-going basis.

- Mr. Marcotte developed ergonomics program implementation strategy and provide on-going technical guidance to engineers, project managers, and ergonomics committees for a major manufacturer of aircraft engines. The work involved conducting worksite analysis to identify department/plant priorities and developing solutions which can be implemented in the short-term. Whenever possible solutions are designed to improve employee/work area performance in addition to minimizing employee exposure to ergonomics risk factors. Currently serving as the Ergonomics Expert/Resource for the aircraft engine manufacturing and testing complex and ad hoc member of several of the most active ergonomics committees. Projects have included developing a material handling device to transport aircraft engines and build fixtures,

evaluating proposed work area/process redesign for the primary packaging and distribution center, developing work area layout for a major administrative area.

- Mr. Marcotte has developed work area and workstation design specifications for an international law firm. The specifications are used to communicate job-specific needs to architects as they design workplaces to accommodate legal secretaries, paralegals, attorneys, information services staff, data processing, and other administrative support personnel. Based on is previous work with the firm, Mr. Marcotte provides on-going ergonomics technical review of office relocation and re-design efforts.

- As an employee of General Motors, Central Foundry Division, Mr. Marcotte provided technical ergonomics design expertise for the development of new foundry process technology. As a former production supervisor and development engineer, Mr. Marcotte's projects (e.g., materials handling, work area layout) have generated increases in molding productivity by 33 percent.

Education/Professional Activities

Mr. Marcotte, a certified professional ergonomist, earned his Master of Science in Industrial and Operations Engineering, specializing in Ergonomics/Occupational Health & Safety Engineering, from the University of Michigan at Ann Arbor. He holds a Bachelor of Science in Industrial and Systems Engineering from the General Motors Institute at Flint, Michigan.

He previously served on the ANSI - Z-365 Subcommittee and is a member of the Human Factors and Ergonomics Society, the American Society of Safety Engineers and the Institute of Industrial Engineers.

Research/Publications

Marcotte, A. J., Barker, R. T. *Level I Ergonomics Assessment Methodology for Maintenance and Inspection Work Areas*, United States Air Force Materiel Command/Armstrong Laboratories, December 1996.

Marcotte, A. J., Barker, R. T. *Level I Ergonomics Assessment Methodology for Administrative Work Areas*, United States Air Force Materiel Command/Armstrong Laboratories, October 1996.

Marcotte, A. J., Barker, R. T. *Job Requirements/Physical Demands Survey Methodology*, United States Air Force Space Command/Armstrong Laboratories, September 1996.
"Ergonomics Applied to Product & Process Design Achieves Immediate, Measurable Cost Savings," HFES, San Diego, CA, October, 1995.

Marcotte, A. J., Weinkamp, P., Jackson, P., and Bretz, T., "Moving Mattresses Safely: A Case Study in Manual Materials Handling," International Ergonomics Association, Warsaw, Poland, June 1993.

Marcotte, Andrew and Adams, Edie, "A Manager's Guide to Ergonomics in the Chemical and Allied Industries," Chemical Manufacturers Association (CMA), 1992.

Marcotte, A. J., “Implementing a Successful Ergonomics Program Using In-House Expertise: Results Through Training, “ Proceedings of the IEA Annual Meeting, Paris, France, July, 1991.

Marcotte, A. J. and Martino, John, “Injury Prevention In An Incentive-based Production Environment: A Case Study,” Proceedings of the IFIESR Annual Meeting, Lake Tahoe, Nevada, June 1991.

Cook, Robert E. and Marcotte, A. J., “Ergonomic Improvement in Games Manufacturing: A Case Study,” Proceedings of the HFS 34th Annual Meeting, Orlando, Florida, October 1990.

Presentations

Marcotte, A.J., "Making a Business Case for Ergonomics," Organization Resources Councelors, Inc., San Francisco, CA, September, 1995.

Marcotte, A.J., "Ergonomics: Value-Added Safety," Fisher Scientific Conference, Two Rivers, WI, March, 1995.

Marcotte, A.J., "Ergonomics Workstation Analysis for the Bedding Industry," International Sleeps Products Association, Albuquerque, NM, March, 1995.

Marcotte, A.J., "How to Develop a Practical Written Ergonomics Plan," Manufacturers' Education Council, Columbus, OH, February, 1995.

Marcotte, A. J., “Ergonomics Measurable Results in the Chemical Industry: Case Studies.” Presentation identifying key applications and results of ergonomics improvements in chemical process operations. National Safety Congress, Chicago, IL. October 1993.

Marcotte, A. J., “Public Utilities and Ergonomics: Problems and Solutions.” Case study presentation identifying potential scope of problems and results of improvements in public utilities work. National Safety Congress, Chicago, IL. October 1993.

APPENDIX B

Usability Questionnaire

Survey

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
ANSWERING THE CHECKLIST QUESTIONS					
The wording of the questions is clear	1	2	3	4	5
The wording of the response choices is clear	1	2	3	4	5
The risk criteria are well defined within each question	1	2	3	4	5
The risk criteria are easily estimated without measurement	1	2	3	4	5
I encountered workplace ergonomics concerns that were not covered by the checklist	1	2	3	4	5
The tool has sufficient breadth of risk identifiers	1	2	3	4	5
I am reasonably certain that most of my responses are correct	1	2	3	4	5
USING THE MATRICES TO IDENTIFY SOLUTIONS					
The descriptions of the recommendations are clear	1	2	3	4	5
The tool provides a sufficient variety of solutions	1	2	3	4	5
The tool is useful for generating solutions	1	2	3	4	5
The tool is better suited to an ergonomist that a non-ergonomist	1	2	3	4	5
I could not find solutions for concern that I identified	1	2	3	4	5
The tool helps me to generate **more** solution options than I would on my own	1	2	3	4	5
The tool helps me to generate **better** solution options than I would on my own	1	2	3	4	5
OVERALL USE OF THE GUIDE					
The tool is well suited for field use	1	2	3	4	5
The tool is useful for ranking jobs	1	2	3	4	5
The scores can be generated quickly and easily	1	2	3	4	5
The activities performed in assembly and warehouse are covered in the tool	1	2	3	4	5
The scores can be clearly interpreted	1	2	3	4	5
The written instructions were easily understood and complete	1	2	3	4	5

Survey

Please provide your comments to each of the following questions

How useful do you think this guide will be for completing ergonomics assessments?

How useful do you think this guide will be for identifying corrective actions?

What aspects of the guide did you find the most useful?

Were there any aspects of the guide that you found difficult or awkward to use?

Other comments:

Results

ANSWERING THE CHECKLIST QUESTIONS	1.928571
The wording of the questions is clear	1.75
The wording of the response choices is clear	1.875
The risk criteria are well defined within each question	1.875
The risk criteria are easily estimated without measurement	2.125
I encountered workplace ergonomics concerns that were not covered by the checklist	2.5
The tool has sufficient breadth of risk identifiers	1.625
I am reasonably certain that most of my responses are correct	1.75
USING THE MATRICES TO IDENTIFY SOLUTIONS	1.910714
The descriptions of the recommendations are clear	1.75
The tool provides a sufficient variety of solutions	1.75
The tool is useful for generating solutions	1.75
The tool is better suited to an ergonomist that a non-ergonomist	2.375
I could not find solutions for concern that I identified	2.375
The tool helps me to generate **more** solution options than I would on my own	1.625
The tool helps me to generate **better** solution options than I would on my own	1.75
OVERALL USE OF THE GUIDE	1.791667
The tool is well suited for field use	1.875
The tool is useful for ranking jobs	1.875

Results

The scores can be generated quickly and easily	1.5
The activities performed in assembly and warehouse are covered in the tool	1.625
The scores can be clearly interpreted	1.625
The written instructions were easily understood and complete	2.25
Please provide your comments to each of the following questions	
How useful do you think this guide will be for completing ergonomics assessments?	
How useful do you think this guide will be for identifying corrective actions?	
What aspects of the guide did you find the most useful?	

Results

Were there any aspects of the guide that you found difficult or awkward to use?	
Other comments:	

Instructions

Person	Each person has their own checklist entry sheet, and summary sheet
note:	complete the summary sheet for each scenario under ergo intials (i.e rbsum)
	complete the checklist entry sheet for each task under ergo's name
Scenario	Enter the information under the scenario numbers already entered
Chk time	enter the elapsed time to complete checklist (only on summary sheet)
Sum Time	enter the elapsed time to complete summary (only on summary sheet)
Order #	already entered
Questions 1 to 24	enter the score corresponding to the response (complete for each task type not for summary
Questions 1 and 16 special note	**ONLY ENTER THE HIGHER OF THE 2 SCORES**
Questions 25 to 28	Enter the score corresponding to the response (enter only on summary sheet)
SN Score	enter the shoulder/neck score for each task on the checklist entry sheet and for the job on the summary sheet
HWA Score	enter the hand/wrist/arm score
BT Score	enter the back/torso score
LF Score	enter the legs/feet score
HE Score	enter the head/eyes score
SN Rating	enter the shoulder/neck rating 3=high, 2=med, 1=low
HWA to HE Ratings	enter the body part ratings as above. The scores and ratings are completed for each task and the summary
Total Rating	enter the rating for the overall job on the summary line described below
Correct Action CA1 to CA69	enter a 1 under each recommendation selected (place these on the summary sheet)

Alpha RB

Scenari	Task #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	SN Sco	HWA S	BT Sco	LF	HE Score
1	1 Prep &	2	0	0	6	5	2	0	2	0	0	0	2	0	0	6	0	0	0	2	0	0	0	0	3	8	9	8	2	3
2	2 Checkout	3	2	0	6	5	1	0	2	0	0	2	3	0	0	0	3	0	0	0	0	0	0	0	0	11	10	6	0	0
3	3 Driving	1	0	0	2	2	0	0	3	0	0	0	0	1	0	2	0	0	2	0	0	0	0	0	0	3	5	5	0	0
3	3 Pack/Ship	1	1	1	2	1	0	0	0	1	0	0	1	1	2	0	4	2	0	2	0	1	0	0	0	5	2	10	3	0
4	4 Lube	2	0	0	2	1	0	0	1	0	0	0	0	1	0	2	0	0	0	0	0	2	0	2	0	4	2	3	2	2
5	5 Cooking	2	1	1	6	5	0	0	2	2	1	2	2	2	2	1	2	0	0	3	0	1	0	0	0	10	12	9	4	0
6	6 pick/stock	3	2	1	1	2	0	0	2	0	1	1	2	2	2	0	4	2	0	3	0	1	0	0	0	7	6	12	4	0
7	7 Serve food	3	1	0	6	2	0	1	0	0	1	0	0	1	2	0	0	0	0	3	0	0	0	0	0	10	4	3	3	0
8	8 Pack/Ship	2	2	0	3	2	0	0	2	2	0	0	2	2	0	0	4	0	0	3	0	2	0	0	0	7	6	8	5	0
9	9 Meat cut	2	2	1	6	5	0	0	4	1	2	3	2	2	0	2	4	2	0	3	0	2	0	0	0	11	15	12	5	0
10	10 Dishwash	3	1	0	3	5	1	0	0	0	1	0	3	4	0	0	2	0	0	3	2	0	0	0	0	7	7	9	5	0

Alpha LM

Scenario #	Task #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	SN Scor	HWA Scor	BT Score	LF Score	HE Score
1	Prep &	2	0	0	6	2	2	0	2	0	2	0	1	1	0	1	0	0	0	1	5	0	0	2	3	8	8	3	6	5
2	Checkout	3	2	1	6	5	1	0	4	0	1	1	1	2	0	0	2	0	0	3	1	0	0	0	0	12	12	5	4	0
3	Driving																													
3	Pack/Ship	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	2	0	3	0	0
4	Lube	2	0	0	3	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	2	2	0	1	0	5	2	2	4	1
5	Cooking	2	1	0	0	2	1	0	1	2	1	1	2	1	0	1	2	0	0	3	1	0	0	0	0	6	8	6	4	0
6	pick/stock	3	2	1	3	2	1	0	2	0	1	0	3	2	0	1	4	2	0	1	1	0	0	0	0	9	6	12	2	0
7	Serve food	3	1	0	0	2	0	0	2	0	2	0	2	1	0	0	2	0	0	2	0	0	0	0	0	4	6	5	2	0
8	Pack/Ship	1	2	0	6	2	1	0	2	0	0	0	1	1	0	0	2	0	0	3	1	0	0	0	0	9	5	4	4	0
9	Meat cut	3	2	1	6	5	1	0	4	0	0	2	2	2	0	2	3	2	0	5	1	0	0	0	0	12	12	11	4	0
10	Dishwash	3	2	0	3	5	2	1	2	0	2	0	2	2	0	0	2	0	0	3	2	0	0	0	0	8	11	6	5	0

Alpha AM

Scen	Task #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	SN Score	HWA Score	BT Scor	LF Score	HE Score
1	Prep &	3	0	0	6	2	1	0	1	0	1	0	2	2	0	6	0	0	0	0	5	0	0	3	2	9	5	10	5	5
2	Checkout	3	2	1	6	5	0	1	2	1	0	1	2	2	2	6	2	0	0	3	2	0	0	0	3	12	10	18	5	3
3	Driving	1	1	0	1	1	0	0	0	1	1	0	1	1	2	1	4	0	0	2	1	0	0	0	0	4	3	11	3	0
3	Pack/Ship	1	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	2	0	2	0	0	0	0	1	3	4	2	0
4	Lube	2	0	0	3	2	0	0	0	0	0	0	0	3	0	2	0	0	0	2	1	1	0	0	0	6	2	5	4	0
5	Cooking	3	1	1	3	5	1	0	1	2	1	1	2	2	2	6	2	0	0	3	1	0	0	0	0	9	11	18	4	0
6	pick/stock	3	2	1	1	2	0	0	2	2	2	2	3	2	3	6	6	3	0	3	1	1	0	0	0	10	10	26	5	0
7	Serve food	3	1	0	6	5	0	0	2	0	1	0	2	1	0	6	4	0	0	3	1	0	0	0	0	12	8	15	4	0
8	Pack/Ship	3	2	1	6	2	0	0	1	1	0	0	3	2	2	6	4	0	0	3	1	0	0	0	0	12	4	19	4	0
9	Meat cut	3	2	1	6	5	0	0	2	2	2	3	2	2	2	6	4	2	0	3	1	0	0	0	0	10	14	21	4	0
10	Dishwash	3	2	1	6	5	0	0	1	9	0	0	3	4	2	6	2	0	0	3	1	0	0	0	0	13	6	17	4	0

Alpha VC

Scenar	Task #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	SN Scor	HWA Sco	BT Scor	LF Score	HE Scor
1	Prep &	1	0	0	3	2	2	0	2	1	1	0	1	1	0	0	0	0	0	0	0	0	0	3	3	4	8	2	0	6
2	Checkout	3	1	1	1	5	1	0	2	1	1	0	2	1	0	2	2	0	0	3	0	0	0	0	2	6	10	7	3	2
3	Driving	0	0	0	2	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	2	0	2	0	0
3	Pack/Ship	1	1	0	1	0	0	0	1	0	0	1	1	1	2	0	2	0	0	1	0	0	0	0	0	2	2	6	1	0
4	Lube	2	0	0	2	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1	0	4	1	2	1	1
5	Cooking	2	1	1	3	2	1	0	1	1	0	1	2	1	0	2	2	0	0	3	5	0	0	0	1	7	6	7	8	1
6	pick/stock	3	2	1	1	1	1	0	4	1	0	1	2	2	2	2	6	2	0	3	5	2	0	0	0	7	8	16	10	0
7	Serve food	2	2	0	3	2	0	0	1	0	1	0	1	0	0	1	2	2	0	3	0	0	0	0	1	6	4	6	3	1
8	Pack/Ship	1	1	0	1	1	0	0	2	0	0	0	1	1	0	0	2	0	0	3	0	0	0	0	0	3	3	4	3	0
9	Meat cut	1	1	1	6	5	1	1	2	1	1	3	1	0	2	2	4	0	0	3	5	0	0	0	3	9	14	9	8	3
10	Dishwash	3	2	1	3	1	1	1	4	1	0	1	3	4	4	2	2	0	0	3	5	0	0	0	2	9	9	15	8	2

Alpha JN

Scenari	Task #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	SN Score	HWA Score	BT Score	LF Score	HE Score
1	Prep &	0	0	0	3	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	5	0	0	3	1	3	6	0	5	4
2	Checkout	3	5	0	6	5	1	0	4	5	0	0	2	1	0	6	0	0	0	3	0	0	0	0	0	14	15	9	3	0
3	Driving	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0
3	Pack/Ship	2	2	2	3	2	1	1	2	2	2	0	2	1	2	2	4	2	0	3	0	0	0	0	0	10	10	15	3	0
4	Lube	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	2	2	0	3	0
5	Cooking	2	1	0	1	2	0	0	2	2	2	0	2	1	2	1	2	0	0	3	0	0	0	0	0	5	8	8	3	0
6	pick/stock	2	2	0	0	1	0	0	2	0	0	1	2	2	3	0	6	3	0	3	0	0	0	0	0	4	4	19	3	0
7	Serve food	3	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3	4	0	3	0
8	Pack/Ship	0	0	0	3	2	0	0	1	0	0	0	1	1	0	0	4	0	0	3	0	0	0	0	0	3	3	9	3	0
9	Meat cut	1	2	5	1	5	0	0	4	0	2	3	2	0	0	1	6	3	0	2	1	0	0	0	0	9	14	15	3	0
10	Dishwash	3	2	2	1	5	0	0	4	0	0	0	2	2	0	1	2	2	0	3	0	0	0	0	0	8	9	9	3	0

Analyst Summary

Analyst	Recs Used	Total Recs	
RB	30	77	
VC	30	66	
AM	42	114	
LM	32	59	
JN	35	70	
	33.8	77.2	
			0.65812

rbsum

CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22	CA23	CA24	CA25	CA26	CA27	CA28
		1																						1				
												1						1			1							
				1							1							1				1	1					
																							1	1				
				1				1				1						1			1	1						1
				1														1			1	1						
								1																1				
	1							1													1							
												1			1		1	1						1				
								1				1						1					1	1				1
0	1	1	0	3	0	0	0	4	0	0	1	4	0	0	1	0	1	6	0	0	4	3	3	5	0	0	0	2

rbsum

CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47	CA48	CA49	CA50	CA51	CA52	CA53	CA54	CA55	CA56
														1												1	
1														1													
				1		1			1										1								
														1													
										1				1							1						
	1											1	1													1	
		1		1									1	1													
	1									1			1								1						
1		1								0		1		1							1					1	
										1											1						
2	2	2	0	2	0	1	0	0	1	3	0	2	3	6	0	0	0	0	1	0	4	0	0	0	0	3	0

CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69	Recs by Job	
													4	
													5	
												1	10	
													3	
													10	
												1	9	
													6	
				1									8	
									1			1	13	
				1									9	
0	0	0	0	2	0	0	0	0	1	0	0	3	Times Rec Used	77

vcsum

CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22	CA23	CA24	CA25	CA26	CA27	CA28
											1	1												1				
															1			1										
								1																				
												1											1	1				
												1																
				1														1			1	1	1	1				
												1						1						1				1
												1			1		1	1					1					
				1				1					1				1	1					1	1				1
0	0	0	0	2	0	0	0	2	0	0	1	5	1	0	2	0	2	5	0	0	1	1	4	5	0	0	0	2

vcsum

CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47	CA48	CA49	CA50	CA51	CA52	CA53	CA54	CA55	CA56
		1												1												1	
														1													
														1													
														1							1						
	1											1	1														
		1		1				1		1											1						
													1													1	
1	1	1		1						1		1	1														
										1										1						1	
1	2	3	0	2	0	0	0	1	0	3	0	2	3	4	0	0	0	0	0	1	2	0	0	0	0	3	0

CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69	Recs by Job	
	1												7	
													3	
													1	
													4	
													3	
				1								1	11	
													9	
											1		3	
			1										13	
				1									12	
0	1	0	1	2	0	0	0	0	0	0	1	1	Times Rec Used	66

Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22	CA23	CA24	CA25	CA26	CA27
2				1										1			1											
3				1											1	1						1		1		1		
3																						1						
1														1									1					
3									1														1					
3																			1				1					
2								1				1				1												
3									1																			
3								1				1						1					1					
3								1				1											1	1	1			
35	0	0	0	2	0	0	0	3	2	0	0	3	0	2	1	2	1	1	1	0	0	2	5	2	1	1	0	0

CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47	CA48	CA49	CA50	CA51	CA52	CA53	CA54
				1						1																
	1										1							1				1				
											1				1											
										1					1			1								
			1								1											1				
		1						1														1				
	1			1										1								1				
									1		1											1				
		1									1		1						1			1				
1											1		1									1				
1	2	2	1	2	0	0	0	1	1	2	6	0	2	1	2	0	0	2	1	0	0	7	0	0	0	0

CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69	Recs by Job	
1															6	
	1														11	
															3	
							1								6	
															5	
1	1														7	
							1								8	
					1								1		6	
															9	
															9	
2	2	0	0	0	1	0	2	0	0	0	0	0	1	0	Times Rec Used	70

amsum

Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22	CA23	CA24	CA25	CA26
3													1	1								1			1		
3													1			1			1			1			1		
3												1	1			1			1			1	1	1			
2								1																1	1		
3					1				1				1						1								
3					1				1			1	1						1				1	1			
3									1				1						1								
3					1				1										1			1					
3												1	1			1		1	1				1		1		
3					1				1				1						1				1	1	1		
42	0	0	0	0	4	0	0	1	5	0	0	3	8	1	0	3	0	1	8	0	0	4	4	4	5	0	0

amsum

CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47	CA48	CA49	CA50	CA51	CA52	CA53
		1									1					1										
		1														1										
	1							1			1	1											1		1	
																1										
	1											1				1							1			
	1		1							1				1							1	1				
	1				1					1		1			1								1			
1										1																
	1	1	1	1		1				1		1		1		1				1			1			
	1											1											1			
1	6	3	2	1	1	1	0	1	0	4	2	5	0	2	1	5	0	0	0	1	1	1	5	0	1	0

CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69	Recs by Job	
1	1					1										10	
	1									1						9	
							1									14	
																4	
	1															9	
	1							1			1	1			1	18	
																9	
	1						1									8	
	1						1		1						1	22	
							1									11	
1	6	0	0	0	0	1	4	1	1	1	1	1	0	0	2	Times Rec Used	114

lmsum

Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22	CA23	CA24	CA25	CA26	CA27
3				1									1												1			
3																1		1				1	1					
1																												
2														1					1									
3					1			1				1							1				1					
3																			1				1					
2																	1		1									
3		1							1										1				1					
3																			1				1					
3																			1				1					
32	0	1	0	1	1	0	0	1	1	0	0	1	1	1	0	1	1	1	7	0	0	1	6	0	1	0	0	0

Imsum

CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47	CA48	CA49	CA50	CA51	CA52	CA53	CA54	CA55
	1									1																	
	1																										
															1												
																						1					
																						1					
1					1																	1					
			1																			1					
											1				1							1				1	
1								1			1		1									1					
2	2	0	1	0	1	0	0	1	0	1	2	0	1	0	2	0	0	0	0	0	0	6	0	0	0	1	0

CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69	Recs by Job	
	1													6	
									1					6	
														0	
														3	
														6	
						1	1						1	6	
	1													6	
	1												1	8	
1							1						1	9	
						1			1					9	
1	3	0	0	0	0	2	2	0	2	0	0	0	3	Times Rec Used	59

CorrAct

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15
		0	0	1	2	0	0	0	0	0	0	0	1	3	2	0	0
		0	0	0	1	0	0	0	0	0	0	0	0	2	0	1	4
		0	0	0	0	1	0	0	0	1	0	0	2	1	0	0	1
		0	0	0	0	0	0	0	1	0	0	0	0	1	2	0	0
		0	0	0	0	3	0	0	1	3	0	0	1	3	0	0	0
		0	0	0	0	3	0	0	0	1	0	0	1	1	0	0	0
		0	0	0	0	0	0	0	1	2	0	0	1	2	0	0	1
		0	2	0	0	1	0	0	0	4	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	1	0	0	0	2	3	0	0	3
		0	0	0	0	2	0	0	1	3	0	0	1	2	1	0	0
	alpha	0	2	1	3	10	0	0	5	14	0	0	9	18	5	1	9

CA16	CA17	CA18	CA19	CA20	CA21	CA22	CA23	CA24	CA25	CA26	CA27	CA28	CA29	CA30	CA31	CA32
1	0	0	0	0	1	0	0	4	0	0	0	0	2	0	1	1
0	1	3	0	0	4	1	1	1	1	0	0	0	4	0	0	0
0	0	2	0	0	2	2	2	0	0	0	0	1	0	0	0	0
0	0	1	0	0	0	1	3	3	0	0	0	0	0	0	0	0
0	0	3	0	0	1	3	0	0	0	0	0	2	0	0	1	0
0	0	5	0	0	2	5	2	1	0	0	0	1	0	4	0	0
1	0	3	0	0	0	0	0	2	0	0	0	3	1	0	2	2
0	0	2	0	0	2	1	0	0	0	0	1	0	0	1	1	0
0	4	4	0	0	0	3	1	2	0	0	0	1	3	3	3	0
0	1	4	0	0	0	3	4	4	0	0	0	5	0	0	0	0
2	6	27	0	0	12	19	13	17	1	0	1	13	10	8	8	3

CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47	CA48	CA49
0	0	0	0	0	3	0	0	0	0	3	0	0	0	0	0	0
0	0	0	0	0	0	1	0	0	0	3	0	0	1	0	0	0
1	0	2	0	0	2	2	0	0	0	1	0	0	0	0	1	0
0	0	0	0	0	1	0	0	0	0	5	0	0	1	0	0	0
0	0	0	0	0	0	3	0	0	0	3	0	0	0	0	0	0
0	0	0	1	1	0	0	0	3	2	0	0	0	0	0	1	1
3	0	0	0	2	0	2	0	0	3	1	0	0	0	0	0	0
0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0
2	0	0	0	1	0	4	0	4	1	3	0	0	0	2	0	0
0	0	0	1	0	0	5	0	2	0	0	0	0	0	0	0	1
6	0	2	2	6	6	17	0	9	8	19	0	0	2	2	2	2

CA50	CA51	CA52	CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66
0	0	0	0	1	4	0	1	1	0	1	0	0	0	0	0	0
1	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0
1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
5	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	3	1	0	0	0	0	1	2	1	0	1	1
4	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0
3	0	0	0	0	2	0	1	0	0	1	2	0	0	0	0	0
4	0	0	0	1	2	1	0	0	0	1	1	0	2	0	0	1
4	0	0	0	0	1	0	0	0	0	0	3	1	0	0	1	0
24	0	1	0	2	14	3	3	1	0	3	8	5	3	1	3	2

CA67	CA68	CA69	CA70
0	0	0	
0	0	0	
0	0	1	
0	0	0	
0	0	0	
0	0	4	
0	0	0	
0	2	1	
0	0	3	
0	0	0	
0	2	9	0

END-USER TEST SUMMARY:
OVERALL AND CORRECTIVE ACTIONS

Appendix C

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Person	Each person has their own checklist entry sheet, and summary sheet
note:	complete the summary sheet for each scenario under ergo intials (i.e rbsum)
	complete the checklist entry sheet for each task under ergo's name
Scenario	Enter the information under the scenario numbers already entered
Chk time	enter the elapsed time to complete checklist (only on summary sheet)
Sum Time	enter the elapsed time to complete summary (only on summary sheet)
Order #	already entered
Questions 1 to 24	enter the score corresponding to the response (complete for each task type not for summary
Questions 1 and 16 special note	**ONLY ENTER THE HIGHER OF THE 2 SCORES**
Questions 25 to 28	Enter the score corresponding to the response (enter only on summary sheet)
SN Score	enter the shoulder/neck score for each task on the checklist entry sheet and for the job on the summary sheet
HWA Score	enter the hand/wrist/arm score
BT Score	enter the back/torso score
LF Score	enter the legs/feet score
HE Score	enter the head/eyes score
SN Rating	enter the shoulder/neck rating 3=high, 2=med, 1=low
HWA to HE Ratings	enter the body part ratings as above. The scores and ratings are completed for each task and the summary
Total Rating	enter the rating for the overall job on the summary line described below
Correct Action CA1 to CA69	enter a 1 under each recommendation selected (place these on the summary sheet)

User A

Scenario #	Task #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	SN Score	HWA Score	BT Score	LF Score	HE Score
1	Prep &	3	2	2	6	5	0	1	4	0	1	0	2	2	0	6	0	0	0		5	0	0	0	3	13	11	10	5	3
2	Checkout	3	2	2	6	5	1	0	1	2	2	1	1	2	2	6	2	0	0	3	5	0	0	0	2	13	12	13	8	2
3	Driving	1	0	0	2	1	0	0	3	1	1	0	1	1	0	2	0	0	2	0	2	0	0	0	0	3	6	6	2	0
3	Pack/Ship	1	2	0	3	1	0	0	1	2	2	1	2	2	3	2	3	2	0	2	2	1	0	0	1	6	7	14	5	1
4	Lube	1	0	0	2	1	0	0	1	1	2	0	2	1	0	2	0	0	0	0	2	2	0	2	0	3	5	5	4	2
5	Cooking	2	1	1	6	5	0	0	4	5	5	2	1	2	3	6	3	2	0	1	5	1	1	0	0	10	21	17	8	0
6	pick/stock	3	2	1	3	1	0	0	1	1	1	2	2	2	3	6	3	3	1	2	2	2	1	0	0	9	6	20	7	0
7	Serve food	2	0	0	1	2	0	0	2	0	2	1	1	1	0	6	2	3	0	3	5	1	0	0	0	3	7	13	9	0
8	Pack/Ship	3	2	5	3	5	0	0	1	5	0	0	2	4	3	2	4	0	0	1	5	1	0	0	0	13	11	15	7	0
9	Meat cut	3	2	1	6	5	0	0	4	1	5	3	2	2	2	6	2	2	0	3	5	0	0	0	0	12	18	16	8	0
10	Dishwash	3	0	2	6	5	0	0	4	0	0	0	3	4	2	6	2	0	0	3	5	0	0	0	3	11	9	17	8	3

User B

Senario	Task #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	SN Sc	HWA S	BT Score	LF Sco	HE Score
1	Prep &	3	0	2	6	5	2	1	2	2	0	0	1	0	0	6	0	0	0	0	5	0	0	2	2	11	12	7	5	4
2	Checkout	1	1	0	2	2	1	1	1	1	0	0	1	0	0	2	0	0	0	2	0	0	0	0	0	4	6	3	2	0
3	Pack/Ship	2	2	0	0	1	1	0	1	0	2	0	2	2	3	2	4	3	0	1	1	0	0	2	0	4	5	16	2	2
4	Lube	2	0	0	3	2	0	1	1	0	0	0	0	3	0	2	0	0	0	0	2	2	0	2	1	5	4	5	4	3
5	Cooking	1	0	2	3	2	0	0	0	3	0	0	0	0	0	2	0	0	1	2	2	0	0	0	0	6	5	3	4	0
6	pick/stock	3	0	1	1	2	2	0	1	2	0	1	1	1	2	2	2	1	0	2	2	0	0	0	0	5	8	9	4	0
7	Serve food	3	1	0	6	2	0	1	2	0	0	0	2	2	0	2	0	0	0	3	2	0	0	0	0	10	5	6	5	0
8	Pack/Ship	1	0	0	3	2	0	0	3	3	0	0	2	1	0	2	2	1	0	2	2	0	0	1	1	4	8	8	4	2
9	Meat cut	3	1	0	6	5	0	1	4	2	0	3	2	1	3	6	0	0	0	3	5	0	0	0	2	10	15	12	8	2
10	Dishwash	1	0	0	3	2	0	0	1	1	0	0	2	3	0	2	0	0	0	1	2	0	0	0	0	4	4	7	3	0
10b	Remove fr	1	1	0	3	2	1	0	1	1	0	0	2	3	2	2	2	0	0	1	1	0	0	0	0	5	5	11	2	0
7b	Food Prep	1	1	0	3	1	0	0	3	0	0	0	1	1	0	1	0	0	0	2	1	0	0	0	0	5	4	3	3	0
2b	Receive fr	1	1	0	2	2	0	0	1	0	0	0	1	0	0	2	0	0	0	2	0	0	0	0	0	4	3	3	2	0
2c	Pass off to	0	0	0	2	2	1	1	0	1	0	0	1	0	0	2	0	0	0	2	0	0	0	0	0	2	5	3	2	0
8b	Weigh	1	1	0	3	1	1	0	0	0	0	0	1	3	0	2	3	0	0	2	2	0	0	1	1	5	2	9	4	2
8c	Load in bin	1	2	0	2	1	0	0	1	0	1	0	2	1	2	2	3	0	0	2	2	0	0	1	1	5	3	10	4	2
5b	Moving pot	3	0	0	3	5	0	0	4	0	0	0	2	1	0	2	3	2	0	3	5	0	0	0	0	6	9	10	8	0
5c	Stiring foo	1	0	2	2	2	0	0	3	3	0	0	1	0	0	2	0	0	0	2	2	0	0	0	0	5	8	3	4	0
9b	Wrapping	1	0	0	3	2	0	0	3	3	0	1	1	0	0	2	0	0	0	2	0	0	0	0	0	4	9	3	2	0
9c	Placing me	1	0	0	3	2	0	1	3	1	0	1	1	1	0	2	0	0	0	2	0	0	0	0	0	4	8	4	2	0
1b	Cleaning	1	0	0	3	2	0	0	1	0	0	0	0	0	0	1	0	0	0	2	0	0	0	2	1	4	3	1	2	3
2b	Packing M	3	1	0	0	2	0	0	0	0	0	0	2	2	0	6	0	2	0	3	0	0	0	2	0	4	2	12	3	2
2c	Weighing	1	2	0	0	0	0	0	1	0	1	0	1	1	2	0	3	2	0	0	0	1	0	0	0	3	2	9	1	0
6b	Loading bo	2	2	0	1	0	0	0	1	0	1	1	2	1	3	0	6	2	0	0	0	0	0	0	0	5	3	14	0	0
6c	Push/Pull	0	0	1	1	0	0	0	3	0	0	1	0	0	0	0	0	3	0	0	0	0	0	0	0	2	4	3	0	0

User C

Senario #	Task #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	SN Sco	HWA S	BT Sco	LF Sco	HE Score
1	Prep &	1	0	2	3	2	1	0	1	0	0	0	1	0	2	0	0	0	0	0	2	0	0	1	1	6	4	3	2	2
2	Checkout	1	1	0	2	2	0	0	0	0	0	0	1	1	0	0	0	0	0	2	0	1	0	0	0	4	2	2	3	0
3	Driving	1	2	1	2	1	0	0	1	1	1	1	2	0	0	0	3	2	0	1	1	1	0	0	0	6	5	7	3	0
3	Pack/Ship	1	2	1	2	1	0	0	1	1	1	1	2	0	2	0	3	3	0	1	1	1	0	0	0	6	5	10	3	0
4	Lube	1	0	0	2	2	0	0	3	0	1	0	2	3	0	2	0	0	0	0	2	2	0	2	0	3	6	7	4	2
5	Cooking	2	2	0	1	1	0	0	3	0	1	1	1	1	2	2	3	1	0	0	1	0	0	0	0	5	6	10	1	0
6	pick/stock	2	5	0	0	1	1	1	4	1	1	1	2	1	2	1	4	3	0	1	1	1	0	0	0	7	10	13	3	0
7	Serve food	2	2	0	2	0	0	0	0	0	0	1	0	0	0	2	3	0	0	2	1	0	0	0	0	6	1	5	3	0
8	Pack/Ship	1	2	0	1	1	0	0	1	1	2	0	2	1	2	1	3	0	0	1	2	1	0	0	0	4	5	9	4	0
9	Meat cut	1	2	0	2	2	0	0	3	1	1	2	2	0	0	2	3	0	0	2	2	0	0	1	1	5	9	7	4	2
10	Dishwash	0	1	0	2	1	0	0	0	0	0	0	1	0	2	0	2	0	0	1	1	0	0	0	0	3	1	5	2	0
1a	Hand Cleaning	1	0	1	3	2	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	1	1	5	3	1	2	2
1b	Visual Inspection	1	0	0	3	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	2	2	4	1	1	2	4
2a	DataEntry	1	0	0	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	2	0	0	1
5a	Chopping	1	1	0	3	2	0	0	0	0	1	1	0	0	0	2	0	0	0	2	1	0	0	0	0	5	4	2	3	0
5b	Stirring	1	1	0	3	2	0	0	3	0	0	0	0	0	0	2	0	0	0	2	1	0	0	0	0	5	5	2	3	0
6a	Replinish	1	1	0	0	0	0	0	3	1	0	0	1	0	0	0	3	1	0	1	0	0	0	0	0	2	4	5	1	0
7a	Dishwash	1	1	0	2	1	0	0	0	0	0	0	0	0	0	2	2	0	0	2	1	0	0	0	0	4	1	4	3	0
8a	label applic	1	2	0	1	1	0	0	1	1	1	0	1	1	0	1	0	0	0	1	2	1	0	1	0	4	4	3	4	1
9a	Unpacking	0	2	0	2	2	0	0	1	0	1	1	1	0	2	1	3	2	0	0	0	0	0	0	0	4	5	9	0	0
9b	Ban Saw	1	2	0	2	2	0	0	3	0	1	2	2	0	0	2	3	0	0	2	2	0	0	1	1	5	8	7	4	2
10a	scaping	1	1	0	2	2	0	0	1	1	0	0	1	0	2	1	2	0	0	2	1	0	0	0	0	4	4	6	3	0
10b	removing	1	1	0	3	2	0	0	1	0	0	0	1	0	2	0	2	0	0	2	1	0	0	0	0	5	3	5	3	0

User D

Senario #	Task #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	SN Sc	HWA	BT Score	LF Score	HE Score
1	Prep &	1	0	0	6	5	0	0	4	0	0	0	0	0	0	6	0	0	0	0	0	0	0	3	3	7	9	6	0	6
2	Checkout	3	0	0	6	5	1	0	2	0	0	1	1	4	2	1	0	2	0	3	0	0	0	0	0	9	9	10	3	0
3	Driving	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
3	Pack/Ship	1	0	0	1	2	1	0	2	0	0	0	0	2	0	0	2	0	0	3	0	1	0	0	0	2	5	4	4	0
4	Lube	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	2	1	0	4	0
5	Cooking	1	0	0	1	1	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	3	1	0	0
6	pick/stock	3	1	1	1	5	0	0	1	2	1	2	1	1	2	0	0	0	0	1	0	1	0	0	0	6	11	4	2	0
7	Serve food	3	0	1	0	5	0	0	0	0	2	0	3	1	0	1	0	0	0	3	5	1	0	0	0	4	7	5	9	0
8	Pack/Ship	1	1	0	2	1	0	0	0	0	0	0	0	1	2	0	2	0	0	2	1	0	0	0	0	4	1	5	3	0
9	Meat cut	3	1	0	3	2	0	0	4	5	0	2	1	1	2	1	2	2	0	2	0	1	0	0	0	7	13	9	3	0
10	Dishwash	3	0	1	3	5	0	0	4	0	0	0	2	4	2	1	0	0	0	3	0	1	0	0	0	7	9	9	4	0
5a	cutting	2	0	0	3	5	0	0	2	2	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	5	9	1	2	0
5b	lifting	0	1	0	1	1	0	0	0	0	0	2	2	1	2	0	2	0	0	0	0	0	0	0	0	2	3	7	0	0
6a	transportn	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0	0	3	0	4	0	0
6b	lifting	1	1	1	1	0	0	0	0	0	0	0	2	0	3	0	5	0	0	0	0	0	0	0	0	4	0	10	0	0
7a	labeling	1	0	0	2	1	0	0	0	0	0	0	0	1	0	0	0	0	0	2	1	0	0	0	0	3	1	1	3	0

User E

Scenario #	Task #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	SN Score	HWA Score	BT Score	LF Score	HE Score
1	Prep &	1	0	0	6	1	0	0	1	0	0	0	0	1	0	1	0	0	0	1	5	0	2	3	3	7	2	2	8	6
2	Checkout	3	5	1	6	5	2	3	0	5	5	1	1	4	2	6	2	0	0	3	5	0	1	1	1	15	21	15	9	2
3	Pack/Ship	3	5	0	6	2	2	0	1	0	2	0	3	4	3	2	4	4	0	3	1	2	2	2	1	14	7	20	8	3
4	Lube	2	1	0	3	2	0	1	3	0	1	0	2	3	2	2	2	0	0	1	2	2	1	2	2	6	7	11	6	4
5	Cooking	1	1	1	3	2	1	0	3	3	2	1	0	0	2	2	2	0	0	2	1	0	0	0	0	6	12	6	3	0
6	pick/stock	3	1	1	1	5	2	0	1	2	2	2	2	4	3	6	3	3	0	3	5	1	1	1	0	6	14	21	10	1
7	Serve food	3	2	1	6	5	0	1	1	0	2	1	1	2	2	6	3	0	0	3	5	0	1	1	0	12	10	14	9	1
8	Pack/Ship	2	5	1	6	5	0	0	1	0	1	0	3	2	2	2	3	2	0	3	2	0	0	2	3	14	7	14	5	5
9	Meat cut	2	2	1	6	5	2	1	4	2	5	2	2	4	2	6	2	3	0	3	5	1	0	1	3	11	21	19	9	4
10	Dishwash	3	1	2	6	5	1	0	4	5	0	2	2	4	2	6	2	0	0	3	1	0	2	0	0	12	17	16	6	0
1b	Packing	3	1	1	6	5	0	1	1	0	2	0	2	4	3	6	4	4	0	3	2	1	1	2	1	11	9	23	7	3
2b	Bagging	3	5	2	6	5	0	0	2	5	5	1	2	4	2	6	3	3	0	3	1	0	0	1	1	16	18	20	4	2
8b	lifting	1	2	0	2	1	0	0	1	0	2	0	2	3	3	2	3	2	0	1	1	1	0	0	0	5	4	15	3	0
8c	Labeling	1	1	0	3	2	1	0	0	3	0	0	0	1	2	1	2	2	0	1	1	1	0	2	2	5	6	8	3	4
9b	lifting	1	1	2	1	0	0	0	1	1	2	2	1	1	2	1	2	2	0	1	1	0	0	0	0	5	6	9	2	0
9c	Packaging	1	1	0	2	2	0	0	1	1	0	1	0	1	2	1	2	1	0	2	1	0	0	0	2	4	5	7	3	2
1b	Disassem	1	0	0	6	5	2	1	1	2	1	0	0	1	0	2	0	0	0	1	5	0	2	2	3	7	12	3	8	5
1c	Cleaning	0	0	0	3	0	0	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	3	2	1	1	0
5b	lifting	1	1	1	2	1	0	0	1	1	0	1	1	1	2	1	2	2	0	2	0	0	0	0	0	5	4	9	2	0
5c	Stiring	1	1	1	2	2	1	0	0	1	1	0	1	3	2	2	2	1	0	2	1	0	0	0	0	5	5	11	3	0
10b	Receiving	3	2	1	6	5	1	0	2	2	0	2	2	4	2	6	2	0	0	3	1	0	2	0	0	12	12	16	6	0
10c	Load/Unlo	3	2	2	6	5	1	0	2	1	1	3	2	4	2	6	2	0	0	3	1	0	2	0	0	13	13	16	6	0
6b	Reaching	3	2	2	3	2	0	0	2	2	2	1	1	1	2	6	2	2	0	3	5	1	1	0	0	10	9	14	10	0
6c	lifting	1	2	2	2	2	0	0	1	1	2	2	2	3	3	1	6	3	0	2	1	1	0	0	0	7	8	18	4	0

User F

Senario #	Task #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	SN Score	HWA Score	BT Score	LF Score	HE Score
1	Prep &	0	0	0	6	5	2	3	4	0	0	0	0	0	0	6	0	0	0	0	2	0	0	3	3	6	14	6	2	6
2	Checkout	3	0	0	6	5	1	2	1	0	0	1	2	4	0	6	0	0	0	3	1	0	0	0	0	9	10	12	4	0
3	Driving																									0	0	0	0	0
3	Pack/Ship	3	1	0	3	2	0	0	2	2	0	2	1	1	2	2	0	3	0	3	1	0	0	0	0	7	8	9	4	0
4	Lube	1	0	0	3	2	0	1	0	0	0	1	0	3	0	2	0	0	0	0	2	2	0	0	0	4	4	5	4	0
5	Cooking	3	2	0	6	5	1	0	4	2	2	2	2	2	2	6	2	2	0	3	5	0	0	0	0	11	16	16	8	0
6	pick/stock	4	2	1	1	5	0	0	1	0	0	2	2	2	3	2	6	3	0	1	5	1	0	0	0	8	8	18	7	0
7	Serve food	3	2	0	6	5	1	1	4	2	2	1	1	1	0	6	0	3	0	3	5	0	0	0	0	11	16	11	8	0
8	Pack/Ship	3	2	1	6	5	1	0	2	5	1	0	3	4	0	6	3	0	0	3	5	0	0	0	3	12	14	16	8	3
9	Meat cut	3	0	2	6	5	2	0	4	0	5	3	3	1	2	2	0	0	0	3	5	0	0	0	0	11	19	8	8	0
10	Dishwash	3	0	5	6	5	1	0	4	5	1	0	3	4	0	6	0	0	0	1	2	0	0	0	0	14	16	13	3	0
8a	typing	1	0	0	3	2	1	0	0	0	0	0	0	0	0	2	0	0	0	2	2	0	0	0	2	4	3	2	4	2
9a	packing	1	0	0	3	2	0	0	0	0	0	2	0	0	0	1	0	3	0	2	2	0	0	0	0	4	4	4	4	0
9b	receiving	1	2	0	0	0	0	0	3	1	1	2	1	1	2	0	2	2	0	0	2	0	0	0	0	3	7	8	2	0
10a	remve/stack	3	0	0	3	5	1	0	2	0	0	0	2	1	0	2	6	3	0	1	0	0	0	0	3	6	8	14	1	3

User G

Senario #	Task #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	SN Score	HWA Score	BT Score	LF Score	HE Score
1	Prep &	2	1	5	6	2	0	3	4	5	2	0	2	1	0	6	0	0	0	1	5	1	0	3	3	14	16	9	7	6
2	Checkout	3	0	1	6	5	2	0	0	0	1	1	1	4	0	2	2	0	0	3	5	0	0	0	3	10	9	9	8	3
3	Driving	0	0	0	2	1	0	0	0	3	1	0	1	1	0	2	0	0	2	0	2	0	1	1	1	2	5	6	3	2
3	Pack/Ship	3	5	2	6	2	1	1	2	2	2	0	3	4	3	2	6	4	0	2	2	2	0	2	2	16	10	22	6	4
4	Lube	3	2	2	3	2	0	1	3	1	2	0	1	3	2	1	0	1	0	0	2	2	0	2	1	10	9	8	4	3
5	Cooking	3	2	1	6	2	0	0	2	1	2	1	3	4	4	6	2	2	0	3	5	2	0	0	0	12	8	21	10	0
6	pick/stock	3	2	2	6	2	0	0	0	0	1	2	3	4	4	0	4	4	0	3	5	5	0	0	0	13	5	19	13	0
7	Serve food	3	2	2	6	5	0	1	2	2	5	3	2	2	3	6	3	0	0	3	5	2	0	2	0	13	18	16	10	2
8	Pack/Ship	3	5	2	6	2	1	0	0	0	0	0	3	4	4	6	4	3	0	2	5	0	0	0	2	16	3	24	7	2
9	Meat cut	3	5	2	6	2	0	0	1	5	5	3	3	4	4	6	6	3	0	3	5	2	0	0	3	16	16	26	10	3
10	Dishwash	3	2	2	3	2	0	0	0	0	0	0	2	3	2	2	2	0	0	1	2	2	0	0	0	10	2	11	5	0
6A	Loading bx	3	1	1	3	1	0	0	0	0	0	1	2	3	3	0	6	3	0	0	0	2	0	1	0	8	2	17	2	1
10a	sep/clean	1	1	2	3	2	0	0	0	0	0	1	1	3	2	2	2	0	0	2	2	1	0	1	0	7	3	10	5	1
																										0	0	0	0	0
																										0	0	0	0	0
																										0	0	0	0	0
																										0	0	0	0	0
																										0	0	0	0	0
																										0	0	0	0	0
																										0	0	0	0	0

User H

Senario #	Task #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	SN Score	HWA Score	BT Score	LF Score	HE Score
1	Prep &	0	0	0	3	5	0	0	4	2	0	0	0	0	0	6	0	0	0	0	5	0	0	3	0	3	11	6	5	3
2	Checkout	4	0	0	1	2	2	0	0	0	0	0	0	2	0	0	0	0	0	3	0	0	0	3	0	5	4	2	3	3
3	Driving	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Pack/Shi	2	2	0	3	1	2	3	4	0	0	0	3	4	3	2	3	0	0	3	0	0	0	0	3	7	10	15	3	3
4	Lube	3	0	0	2	1	0	1	3	1	2	0	1	0	2	1	0	0	0	0	0	2	0	2	0	5	8	4	2	2
5	Cooking	0	0	0	2	2	0	0	3	3	0	0	0	0	0	1	2	0	0	2	0	0	0	0	0	2	8	3	2	0
6	pick/stoc	2	5	0	1	0	0	0	4	0	0	2	1	1	3	2	3	0	0	3	0	0	0	0	0	8	6	10	3	0
7	Serve foo	3	0	0	1	5	0	3	2	0	5	0	2	0	0	2	0	0	0	3	0	0	0	3	0	4	15	4	3	3
8	Pack/Shi	3	2	0	1	1	0	1	1	0	0	0	1	1	2	0	2	0	0	3	0	0	0	0	0	6	3	6	3	0
9	Meat cut	1	2	0	3	5	0	1	4	0	2	3	0	0	6	2	0	0	0	3	5	0	0	0	0	6	15	8	8	0
10	Dishwash	3	0	0	1	2	0	1	4	0	0	0	3	4	0	6	0	0	0	3	0	0	0	0	0	4	7	13	3	0
2a	scanning	3	0	0	6	5	2	3	4	0	1	1	0	0	0	6	0	0	0	3	0	0	0	0	0	9	16	6	3	0
5a	recving M	0	0	0	0	0	0	0	0	0	0	2	2	0	0	2	2	0	0	2	0	0	0	0	0	0	2	6	2	0
5b	cutting	0	0	0	3	0	0	0	1	1	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	3	2	1	2	0
6a	transport	0	0	0	0	2	0	0	3	1	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	6	3	0	0
8a	stocking	1	0	2	1	0	2	0	0	0	0	0	1	1	2	2	3	3	0	0	1	1	0	0	3	4	2	12	2	3
8b	crating	1	0	1	1	0	0	0	3	3	2	0	0	0	2	1	2	0	0	2	0	0	0	1	0	3	8	5	2	1

Asum

Scenario #	Task #	cklst time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating
1	summary	15	8	10	0	0	0	0	13	11	10	5	3	3	3	3	2
2	summary	13	8	9	4	0	4	0	13	12	13	8	2	3	3	3	3
3	summary	17	10	8	4	4	4	4	6	7	14	5	1	3	3	3	2
4	summary	13	6	7	0	1	4	1	3	5	5	4	2	1	2	2	2
5	summary	66	7	6	0	4	1	1	10	21	17	8	0	3	3	3	3
6	summary	17	8	5	0	4	4	1	9	6	20	7	0	3	2	3	2
7	summary	12	8	4	4	4	1	1	3	7	13	9	0	1	2	3	3
8	summary	23	6	3	0	0	1	0	13	11	15	7	0	3	3	3	2
9	summary	26	9	2	4	4	1	0	12	18	16	8	0	3	3	3	3
10	summary	39	34	1	4	4	1	0	11	9	17	8	3	3	3	3	3
3a	summary	17	10	8	4	4	4	4	3	6	6	2	1	3	3	3	2

Asum

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22
1	3													1						1			1	
1	3												1	1			1			1			1	1
1	3		1	1					1	1				1		0	1	1	1	1				1
1	2								1						1									
1	3		1			1	1		1					1						1			1	
1	3					1			1	1		1	1	1			1			1			1	1
1	3									1			1	1		1				1			1	1
1	1					1				1			1							1			1	1
1	3								1	1			1	1			1		1	1				
1	3									1				1			1			1			1	1
1	3		1	1					1	1				1			1	1	1	1				1

Asum

CA23	CA24	CA25	CA26	CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47
1	1					1	1	1		1			1		1				1	1			1	
						1							1			1				1				
1	1		1	1	1		1				1	1		1	1	1			1			1		
1	1																			1				
	1												1			1		1		1				
1	1			1	1		1			1			1	1		1		1		1				
	1							1		1				1		1			1	1	1			
1	1			1	1		1			1			1	1		1			1	1				
	1				1	1		1		1						1		1		1				1
1	1					1								1		1				1				
1	1		1	1	1		1				1	1		1	1	1			1			1		

Asum

CA48	CA49	CA50	CA51	CA52	CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69
1						1	1		1	1		1									
		1					1		1				1			1		1			
1		1		1		1	1			1								1			
		1				1	1			1			1								
1		1				1	1			1			1	1	1						1
		1				1								1							
1		1				1	1			1			1	1	1						1
		1					1											1			
		1					1			1		1									
1		1		1		1	1			1								1			

Senario #	Task #	ckist time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating
1	summary	20	10	3	4	0	1	1	4	5	16	2	2	2	2	3	1
2	summary	32	19	1	1	0	0	0	11	12	7	5	4	3	3	2	2
3	summary	20	10	9	4	1	1	1	10	15	12	8	2	3	3	3	3
4	summary	52		5	4	1	0	1	6	5	3	4	0	2	2	1	2
5	summary	41	13	8	4	1	1	1	4	8	8	4	2	2	3	3	2
6	summary	14	10	2	0	0	0	0	4	6	3	2	0	2	2	1	1
7	summary	19	7	7	1	1	0	1	10	5	6	5	0	3	2	2	2
8	summary	20	9	10	4	1	1	1	4	4	7	3	0	2	2	2	1
9	summary	8	6	4	4	1	1	1	5	4	5	4	3	2	2	2	2
10	summary	25	8	6	4	1	1	0	5	8	9	4	0	2	3	3	2
10b	Remove from washer								5	5	11	2	0	2	2	3	1
7b	Food Prep								5	4	3	3	0	2	2	1	1
2b	Receive from conveyor								4	3	3	2	0	2	1	1	1
2c	Pass off to bager								2	5	3	2	0	1	2	1	1
8b	Weigh								5	2	9	4	2	2	1	3	2
8c	Load in bin								5	3	10	4	2	2	1	3	2
5b	Moving pots/pans								6	9	10	8	0	2	3	3	3
5c	Stiring food								5	8	3	4	0	2	3	1	2
9b	Wrapping meat								4	9	3	2	0	2	3	1	1
9c	Placing meat on trays								4	8	4	2	0	2	3	2	1
1b	Cleaning Mask								4	3	1	2	3	2	1	1	1
2b	Packing Materials								4	2	12	3	2	2	1	3	1
2c	Weighing								3	2	9	1	0	1	1	3	1
6b	Loading boxes								5	3	14	0	0	2	1	3	1
6c	Push/Pulling containers								2	4	3	0	0	1	2	1	1

Bsum

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22	CA23	CA24	CA25
1	3			1		1						1	1		1												
2	3													1	1		1										
1	3					1										0			0	1							
1	3																										
1	3									1										1							
1	2																1			1						1	
1	2									1																	
1	3					1				1										1						1	
1	2								1					1											1	1	
1	3																			1				1		1	
1																											
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Bsum

CA26	CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47	CA48	CA49	CA50	CA51	CA52
				1			1					1	1													1
										1			1				1									
			1	1									1		1						1					
			1							1			1		1		1									
					1											1	1									
													1				1									
																	1									
				1																						

Bsum

CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69
		1														
		1					1									
		1														
		1														
		1			1											
		1														
					1											
																1

Senario #	Task #	cklst time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating
1	summary	30	40	5	4	0	0	0	6	4	3	2	2	2	1	1	1
2	summary	25	15	7	0	0	0	0	4	2	2	3	0	2	1	1	1
3	summary	30	15	10	4	1	0	0	6	5	10	5	0	2	2	2	1
4	summary	15	10	6	0	0	0	0	3	6	7	4	2	1	2	2	2
5	summary	1:27	40	2	0	1	0	0	5	6	10	1	0	2	2	2	1
6	summary	30	15	9	0	4	0	0	7	10	13	3	0	2	2	3	1
7	summary	30	25	3	1	0	1	0	6	1	5	3	0	2	1	2	1
8	summary	25		1	0	0	0	0	4	5	9	4	0	2	2	2	2
9	summary	35	15	8	1	4	0	0	5	9	7	4	2	2	2	2	1
10	summary	35	20	4	0	4	1	0	3	1	5	2	0	2	1	2	1
1a	summary	30	40	5	4	0	0	0	5	3	13	2	2	2	1	1	1
1b	summary	30	40	5	4	0	0	0	4	1	1	2	4	2	1	1	1
3a Drving	summary	30	15	10	4	1	0	0	6	5	7	3	0	2	2	2	1
3b DataEn	summary	30	15	10	4	1	0	0	4	2	0	0	1	2	2	2	1
5achopping	summary	1:27	40	2	0	1	0	0	5	4	2	3	0	2	2	2	1
5bstirring	summary	1:27	40	2	0	1	0	0	5	5	2	3	0	2	2	2	1
6adishwash	summary	30	15	9	0	4	0	0	2	4	5	1	0	2	2	3	1
7aFoodsrv	summary	30	25	3	1	0	1	0	4	1	4	3	0	2	1	2	1
8alabelapp	summary	25		1	0	0	0	0	4	4	3	4	1	2	2	2	2
9a unpack	summary	35	15	8	1	4	0	0	4	5	9	0	0	2	2	2	1
9b ban sw	summary	35	15	8	1	4	0	0	5	8	7	4	2	2	2	2	1
10a scrape	summary	35	20	4	0	4	1	0	4	4	6	3	0	2	1	2	1
10b remving	summary	35	20	4	0	4	1	0	5	3	5	3	0	2	1	2	1

Csum

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22
1	2													1	1								1	
1	2													1						1				
1	3															0			0	1				1
1	1																							
1	3					1		1												1				
1	3					1								1						1				
1	2																			1				
1	3													1						1				
1	3								1					1						1				
1	2								1					1						1				
1	2													1	1								1	
1	2													1	1								1	
1	3																			1				1
1	3																			1				1
1	3					1		1												1				
1	3					1		1												1				
1	3					1								1						1				
1	2																			1				
1	3													1						1				
1	3								1					1						1				
1	3								1					1						1				
1	2								1					1						1				
1	2								1					1						1				

Csum

CA23	CA24	CA25	CA26	CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47
	1				1																			
	1																							
1			1				1																	
1																				1				
					1											1								1
	1						1																	
												1				1			1	1				
1			1				1									1								
	1															1								
					1							1				1		1						
	1				1																			
	1				1																			
1			1				1																	
1			1				1																	
					1											1								1
					1											1								1
	1						1																	
												1				1			1	1				
1			1				1									1								
	1															1								
	1															1								
					1							1				1		1						
					1							1				1		1						

Csum

CA48	CA49	CA50	CA51	CA52	CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69
												1									
							1														
							1						1								
				1									1								1
									1												
							1														
							1					1				1					1
												1									
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							1														
							1														
							1						1								
							1						1								
				1									1								1
									1												
							1														
							1					1				1					1
							1					1				1					1

Senario #	Task #	cklist time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating
1	summary	17	6	7	0	0	0	0	7	9	6	0	6	2	3	2	1
2	summary	16	7	4	4	0	1	0	9	9	10	3	0	3	3	3	1
3	summary	33	12	1	4	1	1	1	2	5	4	4	0	1	2	2	2
4	summary	14	6	8	1	0	1	0	2	1	0	4	0	2	1	0	4
5	summary	29	5	10	0	1	0	0	2	3	1	0	0	1	2	1	1
6	summary	33	7	3	0	4	4	0	6	11	4	2	0				
7	summary	45	14	2	0	0	0	0	4	7	5	9	0	2	3	2	3
8	summary	28	9	9	1	0	1	0	4	1	5	3	0	2	1	2	1
9	summary	32	9	6	4	1	1	0	7	13	9	3	0	2	3	3	1
10	summary	19	8	5	0	0	0	0	7	9	9	4	0	2	3	3	2
3a driving	summary			1					0	1	0	0	0	1	1	1	1
5a cut	summary			10					5	9	1	2	0	2	3	1	1
5b lift	summary			10					2	3	7	0	0	1	1	2	0
6a transp	summary			3					3	0	4	0	0	1	1	2	1
6b lift	summary			3					4	0	10	0	0	2	1	3	1
8a labeling	summary			9					3	1	1	3	0	1	1	1	1

Dsum

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22
2	3			1											1					1				
1	3			1								1		1						1				
1	2			1							1					0	1		0	1				1
0	2																			1				
1	3											1		1						1				
1	3											1	1	1			1			1			1	
1	2					1					1	1								1				1
1	3											1	1	1						1				1
1	3			1								1	1	1						1				
1	2			1							1													
1	3																							
0	3																							
1	3																							
1	3																							
1	2																							

Dsum

CA23	CA24	CA25	CA26	CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47
										1					1					1				1
						1				1					1									
										1														
													1							1				
																1								
						1										1								
	1								1				1			1								
						1										1								
						1			1	1						1								

Dsum

CA48	CA49	CA50	CA51	CA52	CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69
		1							1												
				1					1												
		1																			
		1					1														
		1		1			1	1					1							1	
							1					1									
										1											

Senario #	Task #	ckist time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating
1	summary	44	40	6	1	1	0	0	6	14	21	10	1	2	3	3	3
2	summary	30	27	10	1	4	0	0	12	17	16	6	0	3	3	3	2
3	summary	45	10	5	0	0	0	0	6	12	6	3	0	2	3	2	1
4	summary	23	13	1	4	0	0	0	7	2	2	8	6	2	1	1	3
5	summary	27	15	9	1	0	0	0	11	21	19	9	4	3	3	3	3
6	summary	25	13	8	1	0	0	0	14	7	14	5	5	3	2	3	2
7	summary	8	6	4	0	0	0	0	6	7	11	6	4	2	2	3	2
8	summary	15	15	2	0	0	0	0	15	21	15	9	2	3	3	3	3
9	summary	10	10	7	1	0	0	0	12	10	14	9	1	3	3	3	3
10	summary	15	10	3	1	1	0	0	14	7	20	8	3	3	2	3	3
1b	Packing								11	9	23	7	3	3	3	3	2
2b	Bagging								16	18	20	4	2	3	3	3	2
8b	lifting								5	4	15	3	0	2	2	3	1
8c	Labeling								5	6	8	3	4	2	2	3	1
9b	lifting								5	6	9	2	0	2	2	3	1
9c	Packaging								4	5	7	3	2	2	2	2	1
1b	Disassemble								7	12	3	8	5	2	3	1	3
1c	Cleaning								3	2	1	1	0	1	1	1	1
5b	lifting								5	4	9	2	0	2	2	3	1
5c	Stiring								5	5	11	3	0	2	2	3	1
10b	Receiving								12	12	16	6	0	3	3	3	2
10c	Load/Unload								13	13	16	6	0	3	3	3	2
6b	Reaching								10	9	14	10	0	3	3	3	3
6c	lifting								7	8	18	4	0	2	3	3	2

Esum

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22
1	3		1						1		1	1		1						1				1
1	3				1	1			1		1	1	1	1		1				1			1	1
1	3					1				1						0			0				1	1
2	2													1										
2	3									1			1	1			1			1				
2	3				1					1										1				
2	3								1						1									
1	3												1	1						1			1	1
1	3									1			1	1			1			1				1
1	3					1				1			1							1				1
1																								
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1																								
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1																								
1																								

Esum

CA23	CA24	CA25	CA26	CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47
					1				1							1								
	1				1				1	1						1		1		1				
										1			1											
					1																			
							1							1										
1	1																			1				
	1								1				1	1							1			
	1					1			1	1				1						1				
					1		1																	

Esum

CA48	CA49	CA50	CA51	CA52	CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69	CA69
		1		1										1	1						1	
		1		1			1		1				1	1			1					
							1						1									
							1		1													
							1							1	1							
							1															
						1											1					
							1						1									

Senario #	Task #	cklst time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating
1	summary	10	15	2	4	0	0	0	6	14	6	2	6	2	3	2	1
2	summary	20	40	3	4	0	0	0	9	10	12	4	0	3	3	3	2
3	summary	15	25	4	4	1	1	0	7	8	9	4	0	2	3	3	2
4	summary	10	10	10	0	0	0	0	4	4	5	4	0	2	2	2	2
5	summary	25	15	1	0	4	0	1	11	16	16	8	0	3	3	3	3
6	summary	10	15	7	0	4	0	0	8	8	18	7	0	3	3	3	3
7	summary	20	20	9	4	0	0	0	11	16	11	8	0	3	3	3	3
8	summary	10	15	6	4	0	0	1	12	14	16	8	3	3	3	3	2
9	summary	25	30	5	4	4	0	0	11	19	8	8	0	3	3	3	3
10	summary	20	30	8	4	4	0	4	14	16	13	3	0	3	3	3	1
8a typing	summary			8	4	0	0	1	4	3	2	4	2	2	1	1	2
9a packing	summary								4	4	4	4	0	2	2	2	2
9b recving	summary								3	7	8	2	0	2	3	3	2
10a rem/sta	summary								6	8	14	1	3	2	3	3	1

Fsum

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22
2	2													1	1		1							
1	3													1			1			1			1	
1	3				1					1			1			0			0				1	1
1	2																							
0	3													1									1	
0	3													1						1			1	
1	3									1				1			1			1			1	1
1	3	1			1	1				1				1										
1	2						1										1			1				
1	3									1				1			1			1				1
1	3																							
1	2																							
1	2																							
1	3																							

Fsum

CA23	CA24	CA25	CA26	CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47
								1												1				
	1					1							1	1						1				
			1		1													1	1	1				
1						1												1		1				
1					1		1											1	1					
					1					1						1				1				
	1				1	1	1									1				1				1
1	1	1				1																		

Fsum

CA48	CA49	CA50	CA51	CA52	CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69
							1		1												
							1														
		1				1	1														
		1					1			1			1								1
		1																			
							1			1											
		1					1														1
		1					1			1											

Senario #	Task #	ckist time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating
1	summary	23		8	4	0	0	0	14	16	9	7	6	3	3	3	2
2	summary	15	15	1	4	1	1	0	10	9	9	8	3	3	3	3	3
3	summary	27		2	4	1	1	0	16	10	22	6	4	3	3	3	2
4	summary	15	5	9	1	1	1	0	10	9	8	4	3	3	3	3	2
5	summary	30	15	4	0	4	1	0	12	8	21	10	0	3	3	3	3
6	summary	20	23	10	1	1	0	0	13	5	19	13	0	3	2	3	3
7	summary	10		6	4	4	1	0	13	18	16	10	2	3	3	3	3
8	summary	40	17	5	0	1	1	1	16	3	24	7	2	3	1	3	2
9	summary	20	12	3	4	4	4	0	16	16	26	10	3	3	3	3	3
10	summary	20	13	7	1	4	4	0	10	2	11	5	0	3	1	3	2
3a driving	summary			2					2	5	6	3	2	1	2	2	1
6a ldingbx	summary								8	2	17	2	1	3	1	3	1
10a scp/cln	summary								7	3	10	5	1	2	1	3	2

Gsum

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22
2	3	1							1	1			1	1	1		1			1			1	
1	3												1	1			1			1			1	1
2	3		1		1					1	1		1	1		0	1	1		1			1	1
2	3								1						1				0					
1	3					1	1		1	1			1	1	1		1			1			1	1
1	3					1			1			1								1			1	1
1	3									1			1	1			1			1			1	1
1	3		1	1	1				1	1	1		1		1			1		1				1
1	3					1	1		1	1	1		1	1	1		1		1	1				1
1	3					1				1			1	1	1		1			1			1	1
1	3																							
1	3																							
1	3																							

Gsum

CA23	CA24	CA25	CA26	CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47
1	1				1	1	1	1		1			1		1	1			1	1			1	
1	1					1			1				1	1		1				1	1	1		
1	1		1	1			1						1	1		1		1	1	1	1			
1	1																			1				
	1				1	1							1			1		1		1				
1	1			1	1		1			1			1	1				1	1	1				
	1				1	1		1	1	1				1		1			1	1	1			
1					1		1			1			1	1		1				1				
	1				1	1	1	1	1	1							1	1		1				1
1	1				1	1								1				1		1				

Gsum

CA48	CA49	CA50	CA51	CA52	CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69
1	1	1				1	1	1	1	1		1	1	1				1			1
1	1	1					1		1				1	1		1		1			1
							1			1										1	
		1				1	1			1		1	1								
1						1	1			1				1	1						1
		1				1	1							1			1				
1		1		1			1			1			1		1						1
1		1					1							1			1	1			1
		1					1			1		1	1	1	1		1				

Scenario #	Task #	cklst time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating
1	summary	5	5	5	1	0	0	0	3	11	6	5	3	1	3	2	2
2	summary	10	5	6	4	0	1	0	5	4	2	3	3	2	2	1	1
3	summary	10	5	7	4	0	0	0	7	10	15	3	3	2	3	3	1
4	summary	10	5	2	1	1	1	0	5	8	4	2	2	2	3	2	1
5	summary	20	20	3	0	1	1	0	2	8	3	2	0	2	3	2	2
6	summary	15	10	8	0	4	1	0	8	6	10	3	0	3	2	3	1
7	summary	10	5	10	1	1	1	0	4	15	4	3	3	2	3	2	1
8	summary	15	10	4	1	1	4	0	6	3	6	3	0	2	1	2	1
9	summary	10	5	1	0	4	0	0	6	15	8	8	0	2	3	3	3
10	summary	10	5	9	4	4	1	0	4	7	13	3	0	2	2	3	1
2a scanng	summary								9	16	6	3	0	3	3	2	1
3a driving	summary								0	2	6	2	0	1	1	2	1
5a recvnb	summary								3	2	1	2	0	1	1	1	1
5b cuttung	summary								0	6	3	0	0	1	2	1	1
6a transpt	summary								4	2	12	2	3	2	1	3	1
8a stockng	summary								3	8	5	2	1	1	3	2	1
8b crating	summary																

Hsum

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22
1	3													1	1					1				
1	3													1						1				1
1	3			1		1				1				1	1	0	1		0	1				
1	2								1		1				1									
1	2											1												
1	2					1							1							1				
1	3									1				1	1									
1	3		1	1		1				1		1			1					1				
1	3									1			1	1			1			1				
1	3									1			1				1			1				1
1	3																							
1	2																							
1	2																							
1	2																							
1	3																							
1	3																							

Hsum

CA23	CA24	CA25	CA26	CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47
								1					1							1				
	1												1			1				1		1		
					1									1										
1																		1		1				
																1		1		1				
1					1													1		1				
	1							1	1							1			1	1				
					1									1		1		1						
								1								1		1	1					1
1	1															1		1		1				

Hsum

CA48	CA49	CA50	CA51	CA52	CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69
							1		1			1									
		1					1														
		1								1										1	
		1																			
		1								1											
			1																		
		1		1																	
							1														1
										1											

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10
		1	1	2	0	1	0	0	2	1	1	2
		0	0	1	1	1	0	0	1	0	1	2
		0	2	3	2	3	0	0	1	5	2	0
		0	0	0	0	0	0	0	3	0	1	0
		0	1	0	0	3	2	1	2	3	0	2
		0	0	0	1	4	0	0	2	2	0	2
		0	0	0	0	0	0	0	1	5	0	1
		1	2	2	2	5	0	0	1	5	2	2
		0	0	0	0	1	2	0	4	4	1	1
		0	0	1	0	2	0	0	1	5	0	1
	alpha	2	6	9	6	20	4	1	18	30	8	13

CorrAct

CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22	CA23
2	6	6	0	2	0	0	5	0	0	3	1	2
3	8	1	1	4	0	0	7	0	0	4	4	1
2	3	1	0	4	2	1	6	0	0	3	6	3
0	1	3	0	0	0	0	1	0	0	0	0	4
2	5	1	0	2	0	0	6	0	0	3	1	1
2	3	0	0	2	0	0	7	0	0	3	2	4
3	5	2	1	3	0	0	5	0	0	4	3	1
3	3	2	0	0	1	0	7	0	0	2	4	3
5	7	1	0	5	0	2	7	0	0	0	3	1
4	5	1	0	4	0	0	8	0	0	2	6	4
26	46	18	2	26	3	3	59	0	0	24	30	24

CA24	CA25	CA26	CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36
3	0	0	0	3	2	3	4	1	4	0	0	3
5	0	0	0	1	4	0	0	2	2	0	0	5
2	0	4	2	3	1	4	0	0	1	1	1	1
2	0	0	0	0	1	0	0	0	1	0	0	3
2	0	0	0	3	2	0	0	0	0	0	0	2
4	0	0	2	4	0	5	0	0	2	0	0	2
4	0	0	0	2	2	0	4	2	3	0	1	0
4	0	1	1	3	0	3	0	2	2	0	0	4
6	0	0	0	3	5	2	3	2	3	0	0	0
5	1	0	0	3	4	2	0	1	1	0	1	0
37	1	5	5	25	21	19	11	10	19	1	3	20

CorrAct

CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47	CA48	CA49
0	4	3	0	0	2	5	0	0	2	1	2	1
2	1	5	0	1	0	6	1	2	0	0	1	1
3	1	3	0	3	3	2	1	1	0	1	1	0
0	0	1	0	2	0	6	0	0	0	0	0	0
0	0	5	0	4	0	4	0	0	0	1	0	0
3	0	1	0	4	2	3	0	0	0	0	2	0
2	0	6	0	0	5	7	2	0	0	0	0	0
4	0	6	0	1	1	3	1	0	0	0	2	0
1	0	5	1	3	1	5	0	0	0	4	1	0
2	0	4	0	3	0	3	0	0	0	0	0	0
17	6	39	1	21	14	44	5	3	2	7	9	2

CA50	CA51	CA52	CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62
2	0	2	0	2	5	1	4	2	0	4	1	2
5	0	1	0	0	6	0	4	0	0	1	3	2
2	0	2	0	1	5	0	1	3	0	0	1	0
0	0	0	0	0	2	0	1	0	0	0	0	0
5	0	0	0	3	5	0	0	3	0	1	3	0
3	0	1	0	2	4	0	0	4	0	0	3	3
4	1	0	0	2	3	0	1	0	0	0	0	2
4	0	3	0	1	6	1	0	4	0	0	3	1
3	0	0	0	1	5	0	0	0	0	1	0	1
3	0	0	0	0	5	0	0	5	0	3	2	1
31	1	9	0	12	46	2	11	21	0	10	16	12

CA63	CA64	CA65	CA66	CA67	CA68	CA69	CA70
1	0	0	1	0	0	2	0
0	2	1	2	0	0	1	0
0	0	0	1	0	2	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
3	0	0	0	0	0	4	0
0	0	1	0	0	0	0	0
2	0	0	0	0	1	2	0
0	0	2	2	0	0	3	0
1	1	1	0	0	0	2	0
7	3	5	6	0	3	14	0

APPENDIX D

Alpha and End-User Tests Checklist and Scoring Summaries

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ALPHA TEST
CHECKLIST AND SCORING SUMMARIES

Appendix D

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Scenario	Task #	cklst time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating	HE Rating	Job Rating
1	summary	11	22	8	0	0	0	0	8	9	8	2	3	3	3	3	1	1	3
2	summary	10	10	5	0	0	0	0	11	10	6	0	0	3	3	2	1	1	3
3	summary	24	15	7	0	0	0	0	4	4	8	2	0	2	2	3	1	1	3
4	summary	10	10	10	4	0	0	0	4	2	3	2	2	2	1	1	1	1	2
5	summary	20	13	1	0	1	0	1	10	12	9	4	0	3	3	3	2	1	3
6	summary	10	28	4	0	0	0	0	7	6	12	4	0	2	2	3	2	1	3
7	summary	13	13	2	0	0	0	0	10	4	3	3	0	3	2	1	1	1	3
8	summary	13	14	9	0	0	0	0	7	6	8	5	0	2	2	3	2	1	3
9	summary	15	11	6	0	4	1	0	11	15	12	5	0	3	3	3	2	1	3
10	summary	12	10	3	0	0	4	0	7	7	9	5	0	2	2	3	2	1	3
55	0																		30

Senario #	Task #	ckl st time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating	HE Rating	Job Rating
1	summary	39	20	3	4	0	0	0	4	8	2	0	6	2	3	1	1	2	3
2	summary	22	1	7	4	0	1	0	6	10	7	3	2	2	3	2	1	1	3
3	summary	14	4	6	4	1	0	0	2	1	4	1	0	1	1	2	1	1	2
4	summary	20	2	2	0	0	0	0	4	1	2	1	1	2	1	1	1	1	2
5	summary	24	2	10	0	1	0	0	7	6	7	8	1	2	2	2	3	1	3
6	summary	6	1	9	1	1	4	0	7	8	16	10	0	2	3	3	3	1	3
7	summary	33	7	1	1	0	0	0	6	4	6	3	1	2	2	2	1	1	2
8	summary	17	3	4	0	0	0	0	3	3	4	3	0	1	1	2	1	1	2
9	summary	15	5	8	4	4	0	0	9	14	9	8	3	3	3	3	3	1	3
10	summary	16	6	5	4	1	0	0	9	9	15	8	2	3	3	3	3	1	3
55	0																		30

		Senario #	Task #	cklst time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating	HE Rating
		1	summary	20 min	18 min	10	0	0	0	0	3	6	0	5	4	1	2	1	2	2
		2	summary	not given	not given	9	0	0	0	0	14	15	9	3	0	3	3	3	1	1
		3	summary	30 min	not given	8	0	0	0	0	5	5	9	1.5	0	2	2	3	1	1
		4	summary	33 min	not given	7	0	0	0	0	2	2	0	3	0	1	1	1	1	1
		5	summary	30 min	not given	6	0	0	0	0	5	8	8	3	0	2	3	3	1	1
		6	summary	15 min	17 min	5	0	1	0	0	4	14	19	3	0	2	2	3	1	1
		7	summary	not given	30 min	4	0	0	0	0	3	4	0	3	0	1	2	1	1	1
		8	summary	15 min	25 min	3	0	0	0	0	3	3	9	3	0	1	1	3	1	1
		9	summary	not given	38 min	2	0	0	0	0	9	14	15	3	0	3	3	3	1	1
		10	summary	30 min	26 min	1	0	0	0	0	8	9	9	3	0	3	3	3	1	1
0	0	55	0																	

		Senario #	Task #	cklst time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating	HE Rating
		1	summary	25 min	15 min	1	0	0	0	0	9	5	10	5	5	3	2	3	2	2
		2	summary	5 min	5 min	2	1	0	0	0	12	10	18	5	3	3	3	3	2	1
		3	summary	10 min	25 min	3	0	1	0	0	3	3	8	3	0	1	1	3	1	1
		4	summary	10 min	5 min	4	0	0	0	0	6	2	5	4	0	2	1	2	2	1
		5	summary	20 min	15 min	5	0	1	0	0	9	11	18	4	0	3	3	3	2	1
		6	summary	10 min	10 min	6	0	1	0	0	10	10	26	5	0	3	3	3	2	1
		7	summary	10 min	5 min	7	0	0	0	0	12	8	15	4	0	3	3	3	2	1
		8	summary	10 min	15 min	8	0	0	0	0	12	4	19	4	0	3	2	3	2	1
		9	summary	10 min	15 min	9	1	1	0	0	10	14	21	4	0	3	3	3	2	1
		10	summary	10 min	15 min	10	1	1	0	0	13	6	17	4	0	3	2	3	2	1
0	0	55	0																	

		Scenario #	Task #	cklst time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating	HE Rating
		1	summary	1 hr	30 min	2	0	0	0	0	8	8	3	6	5	3	3	1	2	2
		2	summary	55 min	20 min	6	1	0	1	0	12	12	5	4	0	3	3	2	2	1
		3	summary	50 min	10 min	1	1	1	1	0	2	0	3	0	0	1	1	1	1	1
		4	summary	30 min	15 min	9	1	0	0	0	5	2	2	4	1	2	1	1	2	1
		5	summary	30 min	15 min	4	0	1	0	0	6	8	6	4	0	2	3	2	2	1
		6	summary	40 min	20 min	10	0	0	0	0	9	6	12	2	0	3	2	3	1	1
		7	summary	45 min	15 min	7	1	0	1	0	4	6	5	2	0	2	2	2	1	1
		8	summary	45 min	15 min	5	1	0	0	0	9	5	4	4	0	3	2	2	2	1
		9	summary	45 min	15 min	3	1	0	1	0	12	12	11	4	0	3	3	3	2	1
		10	summary	30 min	10 min	8	1	1	1	0	8	11	6	5	0	3	3	2	2	1
0	0	55	0																	

END-USER TEST
CHECKLIST AND SCORING SUMMARIES

Appendix D

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Scenario #	Task #	ckist time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating
1	summary	15	8	10	0	0	0	0	13	11	10	5	3	3	3	3	2
2	summary	13	8	9	4	0	4	0	13	12	13	8	2	3	3	3	3
3	summary	17	10	8	4	4	4	4	6	7	14	5	1	3	3	3	2
4	summary	13	6	7	0	1	4	1	3	5	5	4	2	1	2	2	2
5	summary	66	7	6	0	4	1	1	10	21	17	8	0	3	3	3	3
6	summary	17	8	5	0	4	4	1	9	6	20	7	0	3	2	3	2
7	summary	12	8	4	4	4	1	1	3	7	13	9	0	1	2	3	3
8	summary	23	6	3	0	0	1	0	13	11	15	7	0	3	3	3	2
9	summary	26	9	2	4	4	1	0	12	18	16	8	0	3	3	3	3
10	summary	39	34	1	4	4	1	0	11	9	17	8	3	3	3	3	3
3a	summary	17	10	8	4	4	4	4	3	6	6	2	1	3	3	3	2

Asum

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22
1	3													1						1			1	
1	3												1	1			1			1			1	1
1	3		1	1					1	1				1		0	1	1	1	1				1
1	2								1						1									
1	3		1			1	1		1					1						1			1	
1	3					1			1	1		1	1	1			1			1			1	1
1	3									1			1	1		1				1			1	1
1	1					1				1			1							1			1	1
1	3								1	1			1	1			1		1	1				
1	3									1				1			1			1			1	1
1	3		1	1					1	1				1			1	1	1	1				1

Asum

CA23	CA24	CA25	CA26	CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47
1	1					1	1	1		1			1		1				1	1			1	
						1							1			1				1				
1	1		1	1	1		1				1	1		1	1	1			1			1		
1	1																			1				
	1												1			1		1		1				
1	1			1	1		1			1			1	1		1		1		1				
	1							1		1				1		1			1	1	1			
1	1			1	1		1			1			1	1		1			1	1				
	1				1	1		1		1						1		1		1				1
1	1					1								1		1				1				
1	1		1	1	1		1				1	1		1	1	1			1			1		

Asum

CA48	CA49	CA50	CA51	CA52	CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69
1						1	1		1	1		1									
		1					1		1				1			1		1			
1		1		1		1	1			1								1			
		1				1	1			1			1								
1		1				1	1			1			1	1	1						1
		1				1								1							
1		1				1	1			1			1	1	1						1
		1					1											1			
		1					1			1		1									
1		1		1		1	1			1								1			

Senario #	Task #	ckist time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating
1	summary	20	10	3	4	0	1	1	4	5	16	2	2	2	2	3	1
2	summary	32	19	1	1	0	0	0	11	12	7	5	4	3	3	2	2
3	summary	20	10	9	4	1	1	1	10	15	12	8	2	3	3	3	3
4	summary	52		5	4	1	0	1	6	5	3	4	0	2	2	1	2
5	summary	41	13	8	4	1	1	1	4	8	8	4	2	2	3	3	2
6	summary	14	10	2	0	0	0	0	4	6	3	2	0	2	2	1	1
7	summary	19	7	7	1	1	0	1	10	5	6	5	0	3	2	2	2
8	summary	20	9	10	4	1	1	1	4	4	7	3	0	2	2	2	1
9	summary	8	6	4	4	1	1	1	5	4	5	4	3	2	2	2	2
10	summary	25	8	6	4	1	1	0	5	8	9	4	0	2	3	3	2
10b	Remove from washer								5	5	11	2	0	2	2	3	1
7b	Food Prep								5	4	3	3	0	2	2	1	1
2b	Receive from conveyor								4	3	3	2	0	2	1	1	1
2c	Pass off to bager								2	5	3	2	0	1	2	1	1
8b	Weigh								5	2	9	4	2	2	1	3	2
8c	Load in bin								5	3	10	4	2	2	1	3	2
5b	Moving pots/pans								6	9	10	8	0	2	3	3	3
5c	Stiring food								5	8	3	4	0	2	3	1	2
9b	Wrapping meat								4	9	3	2	0	2	3	1	1
9c	Placing meat on trays								4	8	4	2	0	2	3	2	1
1b	Cleaning Mask								4	3	1	2	3	2	1	1	1
2b	Packing Materials								4	2	12	3	2	2	1	3	1
2c	Weighing								3	2	9	1	0	1	1	3	1
6b	Loading boxes								5	3	14	0	0	2	1	3	1
6c	Push/Pulling containers								2	4	3	0	0	1	2	1	1

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22	CA23	CA24	CA25
1	3			1		1						1	1		1												
2	3													1	1		1										
1	3					1										0			0	1							
1	3																										
1	3									1										1							
1	2																1			1						1	
1	2									1																	
1	3					1				1										1						1	
1	2								1					1											1	1	
1	3																			1				1		1	
1																											
1																											
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1																											
1																											

Bsum

CA26	CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47	CA48	CA49	CA50	CA51	CA52
				1			1					1	1													1
										1			1				1									
			1	1									1		1						1					
			1							1			1		1		1									
					1											1	1									
													1				1									
																	1									
				1																						

Bsum

CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69
		1														
		1					1									
		1														
		1														
		1			1											
		1														
					1											
																1

Csum

Senario #	Task #	ckist time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating
1	summary	30	40	5	4	0	0	0	6	4	3	2	2	2	1	1	1
2	summary	25	15	7	0	0	0	0	4	2	2	3	0	2	1	1	1
3	summary	30	15	10	4	1	0	0	6	5	10	5	0	2	2	2	1
4	summary	15	10	6	0	0	0	0	3	6	7	4	2	1	2	2	2
5	summary	1:27	40	2	0	1	0	0	5	6	10	1	0	2	2	2	1
6	summary	30	15	9	0	4	0	0	7	10	13	3	0	2	2	3	1
7	summary	30	25	3	1	0	1	0	6	1	5	3	0	2	1	2	1
8	summary	25		1	0	0	0	0	4	5	9	4	0	2	2	2	2
9	summary	35	15	8	1	4	0	0	5	9	7	4	2	2	2	2	1
10	summary	35	20	4	0	4	1	0	3	1	5	2	0	2	1	2	1
1a	summary	30	40	5	4	0	0	0	5	3	13	2	2	2	1	1	1
1b	summary	30	40	5	4	0	0	0	4	1	1	2	4	2	1	1	1
3a Drving	summary	30	15	10	4	1	0	0	6	5	7	3	0	2	2	2	1
3b DataEn	summary	30	15	10	4	1	0	0	4	2	0	0	1	2	2	2	1
5achopping	summary	1:27	40	2	0	1	0	0	5	4	2	3	0	2	2	2	1
5bstirring	summary	1:27	40	2	0	1	0	0	5	5	2	3	0	2	2	2	1
6adishwash	summary	30	15	9	0	4	0	0	2	4	5	1	0	2	2	3	1
7aFoodsrv	summary	30	25	3	1	0	1	0	4	1	4	3	0	2	1	2	1
8alabelapp	summary	25		1	0	0	0	0	4	4	3	4	1	2	2	2	2
9a unpack	summary	35	15	8	1	4	0	0	4	5	9	0	0	2	2	2	1
9b ban sw	summary	35	15	8	1	4	0	0	5	8	7	4	2	2	2	2	1
10a scrape	summary	35	20	4	0	4	1	0	4	4	6	3	0	2	1	2	1
10b remving	summary	35	20	4	0	4	1	0	5	3	5	3	0	2	1	2	1

Csum

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22
1	2													1	1								1	
1	2													1						1				
1	3															0			0	1				1
1	1																							
1	3					1		1												1				
1	3					1								1						1				
1	2																			1				
1	3													1						1				
1	3								1					1						1				
1	2								1					1						1				
1	2													1	1								1	
1	2													1	1								1	
1	3																			1				1
1	3																			1				1
1	3					1		1												1				
1	3					1		1												1				
1	3					1								1						1				
1	2																			1				
1	3													1						1				
1	3								1					1						1				
1	3								1					1						1				
1	2								1					1						1				
1	2								1					1						1				

Csum

CA23	CA24	CA25	CA26	CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47
	1				1																			
	1																							
1			1				1																	
1																				1				
					1											1								1
	1						1																	
												1				1			1	1				
1			1				1									1								
	1															1								
					1							1				1		1						
	1				1																			
	1				1																			
1			1				1																	
1			1				1																	
					1											1								1
					1											1								1
	1						1																	
												1				1			1	1				
1			1				1									1								
	1															1								
	1															1								
					1							1				1		1						
					1							1				1		1						

Csum

CA48	CA49	CA50	CA51	CA52	CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69
												1									
							1														
							1						1								
				1									1								1
									1												
							1														
							1					1				1					1
												1									
												1									
							1														
							1														
							1						1								
							1						1								
				1									1								1
									1												
							1														
							1					1				1					1
							1					1				1					1

Senario #	Task #	ckist time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating
1	summary	17	6	7	0	0	0	0	7	9	6	0	6	2	3	2	1
2	summary	16	7	4	4	0	1	0	9	9	10	3	0	3	3	3	1
3	summary	33	12	1	4	1	1	1	2	5	4	4	0	1	2	2	2
4	summary	14	6	8	1	0	1	0	2	1	0	4	0	2	1	0	4
5	summary	29	5	10	0	1	0	0	2	3	1	0	0	1	2	1	1
6	summary	33	7	3	0	4	4	0	6	11	4	2	0				
7	summary	45	14	2	0	0	0	0	4	7	5	9	0	2	3	2	3
8	summary	28	9	9	1	0	1	0	4	1	5	3	0	2	1	2	1
9	summary	32	9	6	4	1	1	0	7	13	9	3	0	2	3	3	1
10	summary	19	8	5	0	0	0	0	7	9	9	4	0	2	3	3	2
3a driving	summary			1					0	1	0	0	0	1	1	1	1
5a cut	summary			10					5	9	1	2	0	2	3	1	1
5b lift	summary			10					2	3	7	0	0	1	1	2	0
6a transp	summary			3					3	0	4	0	0	1	1	2	1
6b lift	summary			3					4	0	10	0	0	2	1	3	1
8a labeling	summary			9					3	1	1	3	0	1	1	1	1

Dsum

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22
2	3			1											1					1				
1	3			1								1		1						1				
1	2			1							1					0	1		0	1				1
0	2																			1				
1	3											1		1						1				
1	3											1	1	1			1			1			1	
1	2					1					1	1								1				1
1	3											1	1	1						1				1
1	3			1								1	1	1						1				
1	2			1							1													
1	3																							
0	3																							
1	3																							
1	3																							
1	2																							

Dsum

CA23	CA24	CA25	CA26	CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47
										1					1					1				1
						1				1					1									
										1														
													1							1				
																1								
						1										1								
	1								1				1			1								
						1										1								
						1			1	1						1								

Dsum

CA48	CA49	CA50	CA51	CA52	CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69
		1							1												
				1					1												
		1																			
		1					1														
		1		1			1	1					1							1	
							1					1									
										1											

Senario #	Task #	ckist time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating
1	summary	44	40	6	1	1	0	0	6	14	21	10	1	2	3	3	3
2	summary	30	27	10	1	4	0	0	12	17	16	6	0	3	3	3	2
3	summary	45	10	5	0	0	0	0	6	12	6	3	0	2	3	2	1
4	summary	23	13	1	4	0	0	0	7	2	2	8	6	2	1	1	3
5	summary	27	15	9	1	0	0	0	11	21	19	9	4	3	3	3	3
6	summary	25	13	8	1	0	0	0	14	7	14	5	5	3	2	3	2
7	summary	8	6	4	0	0	0	0	6	7	11	6	4	2	2	3	2
8	summary	15	15	2	0	0	0	0	15	21	15	9	2	3	3	3	3
9	summary	10	10	7	1	0	0	0	12	10	14	9	1	3	3	3	3
10	summary	15	10	3	1	1	0	0	14	7	20	8	3	3	2	3	3
1b	Packing								11	9	23	7	3	3	3	3	2
2b	Bagging								16	18	20	4	2	3	3	3	2
8b	lifting								5	4	15	3	0	2	2	3	1
8c	Labeling								5	6	8	3	4	2	2	3	1
9b	lifting								5	6	9	2	0	2	2	3	1
9c	Packaging								4	5	7	3	2	2	2	2	1
1b	Disassemble								7	12	3	8	5	2	3	1	3
1c	Cleaning								3	2	1	1	0	1	1	1	1
5b	lifting								5	4	9	2	0	2	2	3	1
5c	Stiring								5	5	11	3	0	2	2	3	1
10b	Receiving								12	12	16	6	0	3	3	3	2
10c	Load/Unload								13	13	16	6	0	3	3	3	2
6b	Reaching								10	9	14	10	0	3	3	3	3
6c	lifting								7	8	18	4	0	2	3	3	2

Esum

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22
1	3		1						1		1	1		1						1				1
1	3				1	1			1		1	1	1	1		1				1			1	1
1	3					1				1						0			0				1	1
2	2													1										
2	3									1			1	1			1			1				
2	3				1					1										1				
2	3								1						1									
1	3												1	1						1			1	1
1	3									1			1	1			1			1				1
1	3					1				1			1							1				1
1																								
1																								
1																								
2																								
1																								
1																								
2																								
1																								
1																								
1																								
1																								
1																								
1																								
1																								

Esum

CA23	CA24	CA25	CA26	CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47
					1				1							1								
	1				1				1	1						1		1		1				
										1			1											
					1																			
							1							1										
1	1																			1				
	1								1				1	1							1			
	1					1			1	1				1						1				
					1		1																	

Esum

CA48	CA49	CA50	CA51	CA52	CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69	CA69
		1		1										1	1						1	
		1		1			1		1				1	1			1					
							1						1									
							1		1													
							1							1	1							
							1															
						1											1					
							1						1									

Fsum

Senario #	Task #	ckist time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating
1	summary	10	15	2	4	0	0	0	6	14	6	2	6	2	3	2	1
2	summary	20	40	3	4	0	0	0	9	10	12	4	0	3	3	3	2
3	summary	15	25	4	4	1	1	0	7	8	9	4	0	2	3	3	2
4	summary	10	10	10	0	0	0	0	4	4	5	4	0	2	2	2	2
5	summary	25	15	1	0	4	0	1	11	16	16	8	0	3	3	3	3
6	summary	10	15	7	0	4	0	0	8	8	18	7	0	3	3	3	3
7	summary	20	20	9	4	0	0	0	11	16	11	8	0	3	3	3	3
8	summary	10	15	6	4	0	0	1	12	14	16	8	3	3	3	3	2
9	summary	25	30	5	4	4	0	0	11	19	8	8	0	3	3	3	3
10	summary	20	30	8	4	4	0	4	14	16	13	3	0	3	3	3	1
8a typing	summary			8	4	0	0	1	4	3	2	4	2	2	1	1	2
9a packing	summary								4	4	4	4	0	2	2	2	2
9b recving	summary								3	7	8	2	0	2	3	3	2
10a rem/sta	summary								6	8	14	1	3	2	3	3	1

Fsum

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22
2	2													1	1		1							
1	3													1			1			1			1	
1	3				1					1			1			0			0				1	1
1	2																							
0	3													1									1	
0	3													1						1			1	
1	3									1				1			1			1			1	1
1	3	1			1	1				1				1										
1	2						1										1			1				
1	3									1				1			1			1				1
1	3																							
1	2																							
1	2																							
1	3																							

Fsum

CA23	CA24	CA25	CA26	CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47
								1												1				
	1					1							1	1						1				
			1		1													1	1	1				
1						1												1		1				
1					1		1											1	1					
					1					1						1				1				
	1				1	1	1									1				1				1
1	1	1				1																		

Fsum

CA48	CA49	CA50	CA51	CA52	CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69
							1		1												
							1														
		1				1	1														
		1					1			1			1								1
		1																			
							1			1											
		1					1														1
		1					1			1											

Senario #	Task #	ckist time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating
1	summary	23		8	4	0	0	0	14	16	9	7	6	3	3	3	2
2	summary	15	15	1	4	1	1	0	10	9	9	8	3	3	3	3	3
3	summary	27		2	4	1	1	0	16	10	22	6	4	3	3	3	2
4	summary	15	5	9	1	1	1	0	10	9	8	4	3	3	3	3	2
5	summary	30	15	4	0	4	1	0	12	8	21	10	0	3	3	3	3
6	summary	20	23	10	1	1	0	0	13	5	19	13	0	3	2	3	3
7	summary	10		6	4	4	1	0	13	18	16	10	2	3	3	3	3
8	summary	40	17	5	0	1	1	1	16	3	24	7	2	3	1	3	2
9	summary	20	12	3	4	4	4	0	16	16	26	10	3	3	3	3	3
10	summary	20	13	7	1	4	4	0	10	2	11	5	0	3	1	3	2
3a driving	summary			2					2	5	6	3	2	1	2	2	1
6a ldingbx	summary								8	2	17	2	1	3	1	3	1
10a scp/cln	summary								7	3	10	5	1	2	1	3	2

Gsum

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22
2	3	1							1	1			1	1	1		1			1			1	
1	3												1	1			1			1			1	1
2	3		1		1					1	1		1	1		0	1	1		1			1	1
2	3								1						1				0					
1	3					1	1		1	1			1	1	1		1			1			1	1
1	3					1			1			1								1			1	1
1	3									1			1	1			1			1			1	1
1	3		1	1	1				1	1	1		1		1			1		1				1
1	3					1	1		1	1	1		1	1	1		1		1	1				1
1	3					1				1			1	1	1		1			1			1	1
1	3																							
1	3																							
1	3																							

Gsum

CA23	CA24	CA25	CA26	CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47
1	1				1	1	1	1		1			1		1	1			1	1			1	
1	1					1			1				1	1		1				1	1	1		
1	1		1	1			1						1	1		1		1	1	1	1			
1	1																			1				
	1				1	1							1			1		1		1				
1	1			1	1		1			1			1	1				1	1	1				
	1				1	1		1	1	1				1		1			1	1	1			
1					1		1			1			1	1		1				1				
	1				1	1	1	1	1	1							1	1		1				1
1	1				1	1								1				1		1				

Gsum

CA48	CA49	CA50	CA51	CA52	CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69
1	1	1				1	1	1	1	1		1	1	1				1			1
1	1	1					1		1				1	1		1		1			1
							1			1										1	
		1				1	1			1		1	1								
1						1	1			1				1	1						1
		1				1	1							1			1				
1		1		1			1			1			1		1						1
1		1					1							1			1	1			1
		1					1			1		1	1	1	1		1				

Scenario #	Task #	cklst time	Sum Time	Order #	25	26	27	28	SN Score	HWA Score	BT Score	LF Score	HE Score	SN Rating	HWA Rating	BT Rating	LF Rating
1	summary	5	5	5	1	0	0	0	3	11	6	5	3	1	3	2	2
2	summary	10	5	6	4	0	1	0	5	4	2	3	3	2	2	1	1
3	summary	10	5	7	4	0	0	0	7	10	15	3	3	2	3	3	1
4	summary	10	5	2	1	1	1	0	5	8	4	2	2	2	3	2	1
5	summary	20	20	3	0	1	1	0	2	8	3	2	0	2	3	2	2
6	summary	15	10	8	0	4	1	0	8	6	10	3	0	3	2	3	1
7	summary	10	5	10	1	1	1	0	4	15	4	3	3	2	3	2	1
8	summary	15	10	4	1	1	4	0	6	3	6	3	0	2	1	2	1
9	summary	10	5	1	0	4	0	0	6	15	8	8	0	2	3	3	3
10	summary	10	5	9	4	4	1	0	4	7	13	3	0	2	2	3	1
2a scanng	summary								9	16	6	3	0	3	3	2	1
3a driving	summary								0	2	6	2	0	1	1	2	1
5a recvnb	summary								3	2	1	2	0	1	1	1	1
5b cuttung	summary								0	6	3	0	0	1	2	1	1
6a transpt	summary								4	2	12	2	3	2	1	3	1
8a stockng	summary								3	8	5	2	1	1	3	2	1
8b crating	summary																

Hsum

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22
1	3													1	1					1				
1	3													1						1				1
1	3			1		1				1				1	1	0	1		0	1				
1	2								1		1				1									
1	2											1												
1	2					1							1							1				
1	3									1				1	1									
1	3		1	1		1				1		1			1					1				
1	3									1			1	1			1			1				
1	3									1			1				1			1				1
1	3																							
1	2																							
1	2																							
1	2																							
1	3																							
1	3																							

Hsum

CA23	CA24	CA25	CA26	CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47
								1					1							1				
	1												1			1				1		1		
					1									1										
1																		1		1				
																1		1		1				
1					1													1		1				
	1							1	1							1			1	1				
					1									1		1		1						
								1								1		1	1					1
1	1															1		1		1				

Hsum

CA48	CA49	CA50	CA51	CA52	CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62	CA63	CA64	CA65	CA66	CA67	CA68	CA69
							1		1			1									
		1					1														
		1								1										1	
		1																			
		1								1											
			1																		
		1		1																	
							1														1
										1											

CorrAct

HE Rating	Job Rating	CA1	CA2	CA3	CA4	CA5	CA6	CA6	CA7	CA8	CA9	CA10
		1	1	2	0	1	0	0	2	1	1	2
		0	0	1	1	1	0	0	1	0	1	2
		0	2	3	2	3	0	0	1	5	2	0
		0	0	0	0	0	0	0	3	0	1	0
		0	1	0	0	3	2	1	2	3	0	2
		0	0	0	1	4	0	0	2	2	0	2
		0	0	0	0	0	0	0	1	5	0	1
		1	2	2	2	5	0	0	1	5	2	2
		0	0	0	0	1	2	0	4	4	1	1
		0	0	1	0	2	0	0	1	5	0	1
	alpha	2	6	9	6	20	4	1	18	30	8	13

CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20	CA21	CA22	CA23
2	6	6	0	2	0	0	5	0	0	3	1	2
3	8	1	1	4	0	0	7	0	0	4	4	1
2	3	1	0	4	2	1	6	0	0	3	6	3
0	1	3	0	0	0	0	1	0	0	0	0	4
2	5	1	0	2	0	0	6	0	0	3	1	1
2	3	0	0	2	0	0	7	0	0	3	2	4
3	5	2	1	3	0	0	5	0	0	4	3	1
3	3	2	0	0	1	0	7	0	0	2	4	3
5	7	1	0	5	0	2	7	0	0	0	3	1
4	5	1	0	4	0	0	8	0	0	2	6	4
26	46	18	2	26	3	3	59	0	0	24	30	24

CorrAct

CA24	CA25	CA26	CA27	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36
3	0	0	0	3	2	3	4	1	4	0	0	3
5	0	0	0	1	4	0	0	2	2	0	0	5
2	0	4	2	3	1	4	0	0	1	1	1	1
2	0	0	0	0	1	0	0	0	1	0	0	3
2	0	0	0	3	2	0	0	0	0	0	0	2
4	0	0	2	4	0	5	0	0	2	0	0	2
4	0	0	0	2	2	0	4	2	3	0	1	0
4	0	1	1	3	0	3	0	2	2	0	0	4
6	0	0	0	3	5	2	3	2	3	0	0	0
5	1	0	0	3	4	2	0	1	1	0	1	0
37	1	5	5	25	21	19	11	10	19	1	3	20

CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45	CA46	CA47	CA48	CA49
0	4	3	0	0	2	5	0	0	2	1	2	1
2	1	5	0	1	0	6	1	2	0	0	1	1
3	1	3	0	3	3	2	1	1	0	1	1	0
0	0	1	0	2	0	6	0	0	0	0	0	0
0	0	5	0	4	0	4	0	0	0	1	0	0
3	0	1	0	4	2	3	0	0	0	0	2	0
2	0	6	0	0	5	7	2	0	0	0	0	0
4	0	6	0	1	1	3	1	0	0	0	2	0
1	0	5	1	3	1	5	0	0	0	4	1	0
2	0	4	0	3	0	3	0	0	0	0	0	0
17	6	39	1	21	14	44	5	3	2	7	9	2

CorrAct

CA50	CA51	CA52	CA53	CA54	CA55	CA56	CA57	CA58	CA59	CA60	CA61	CA62
2	0	2	0	2	5	1	4	2	0	4	1	2
5	0	1	0	0	6	0	4	0	0	1	3	2
2	0	2	0	1	5	0	1	3	0	0	1	0
0	0	0	0	0	2	0	1	0	0	0	0	0
5	0	0	0	3	5	0	0	3	0	1	3	0
3	0	1	0	2	4	0	0	4	0	0	3	3
4	1	0	0	2	3	0	1	0	0	0	0	2
4	0	3	0	1	6	1	0	4	0	0	3	1
3	0	0	0	1	5	0	0	0	0	1	0	1
3	0	0	0	0	5	0	0	5	0	3	2	1
31	1	9	0	12	46	2	11	21	0	10	16	12

CA63	CA64	CA65	CA66	CA67	CA68	CA69	CA70
1	0	0	1	0	0	2	0
0	2	1	2	0	0	1	0
0	0	0	1	0	2	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
3	0	0	0	0	0	4	0
0	0	1	0	0	0	0	0
2	0	0	0	0	1	2	0
0	0	2	2	0	0	3	0
1	1	1	0	0	0	2	0
7	3	5	6	0	3	14	0

APPENDIX E

Job Scenarios

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	Scenario	Base	Tasks
1	Prepare and Inspect Oxygen Mask	Eglin	Prepare & Inspect Life Support Equipment 8 hours/day
2	Cashiers	WP	Cashier 8 hours/day
3	Pack & Crate	Peterson	Packing/Shipping 6 hours/day Driving 2 hours/day
4	Lubricating Trailers	Hill	Lubricate 2 hours/day
5	Cooking	Hill	Cooking 8 hours/day
6	Stock Commissary	WP	Stocking 8 hours/day
7	Food Service	Hill	Food Serving 6 hours/day
8	Warehouse	W-R	Packing/Shipping 6 hours/day
9	Meat Cutting	Hill	Meat Cutting 8 hours/day
10	Dishwashing	Eglin	Dishwashing 8 hours/day